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The Effect of a Varying Moisture Supply at Different Periods of Growth on the Development, Yield and Quality of Flax

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THE EFFECT OF A VARYING MOISTURE SUPPLY AT DIFFERENT PERIODS OF GROWTH ON THE DEVELOPMENT, YIELD AND QUALITY OF FLAX

-By-

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INTRODUCTION

In the flaxseed producing section of the United States consisting of the states of North Dakota, South Dakota, Minnesota and Montana, periods of drouth frequently occur during some part of the growing season. The time of occurrence varies from early spring to fall. Such periods have a profound effect on the normal growth of the plant. This effect may be manifested in any one of several ways: total failure, decreased yield of seed, failure of plants to reach normal height and a combination of decrease in yield and plant height less than normal.

At the same time such periods of drouth may have an abnormal effect on the quality of flaxseed produced. Since the amount of oil expressed or extracted is of major importance to flaxseed users, this quality may be measured in terms of the percent of oil produced.

With the above in mind an investigation was planned to determine quantitatively the effects of drouth on flax plants. Because of the difficulty of controlling moisture under field conditions, it was necessary to grow them in the greenhouse. While such conditions are very artificial and the results are dissimilar to field results under natural conditions, yet relatively they may be compared and conclusions drawn.

REVIEW OF LITERATURE

One of the earlier workers in the field of water relationships was Hellriegel who in 1883 reported on the detrimental effect of drouth. Shortly after, Gain (4) repeated Hellreigel's experiment and secured opposite results, namely that an intermittent drouth period increased the returns.

Tinsley and Vernon (19) concluded that even when the soil was dry up to the heading stage, an ample amount of moisture at the filling stage gave as good returns as continuous optimum moisture. Pulman (15) found that a high degree of soil humidity at the seed forming time was essential for a good yield of buckwheat.

Pfeiffer, Blanck, and Friske (12) found that the ratio of grain to total yield decreases as the water supply increases.

Pfeiffer, et al (13) repeated the work of Hellriegel and Gain and their results were similar to those of Hellriegel. They found a difference in favor of continuous optimum moisture of from 3% to 25% over a similar planting which experienced a drouth period.

With regard to the morphology, Eberhard (3) concluded that drouth periods are associated with dwarfing of stems, but with increased regidity and increased number of internodes.

Preul (14) working with wheat, found that under optimum moisture conditions all parts of the plants except the roots exceeded similar plants having a limited supply of moisture during some stage of growth. Kiesselbach (7) obtained substantially the same results.

Widstoe (20) working under irrigated conditions found that the percentage weight of heads is greater for heavy irrigations than for light ones. He also concluded that later irrigations are especially benefecial in the case of wheat.

Mayer (10) Wilms and von Seelharst (21) and LeClerc (9) all concluded that an arid condition is most favorable to high protein content.

Widstoe (20) found that with a high soil water content, the amounts of nitrogen-free extract and of fats were higher.

King (8) found that rapidly growing vigorous plants produce more dry matter per unit of water than do weaker plants. Von Seelharst (18) working with oats observed that the most luxuriant growths produced the largest dry weights.

Heinrich (6) Shroeder (17) and Busyoncos (1) concluded that the greater the concentration of nutrient solutions, the greater the water economy in producing dry matter. However Kiesselbach (7) noted the opposite and his conclusion is that neither soil humidity nor concentration of nutrient solution have much effect on water economy.

EXPERIMENTAL CONDITIONS AND METHODS

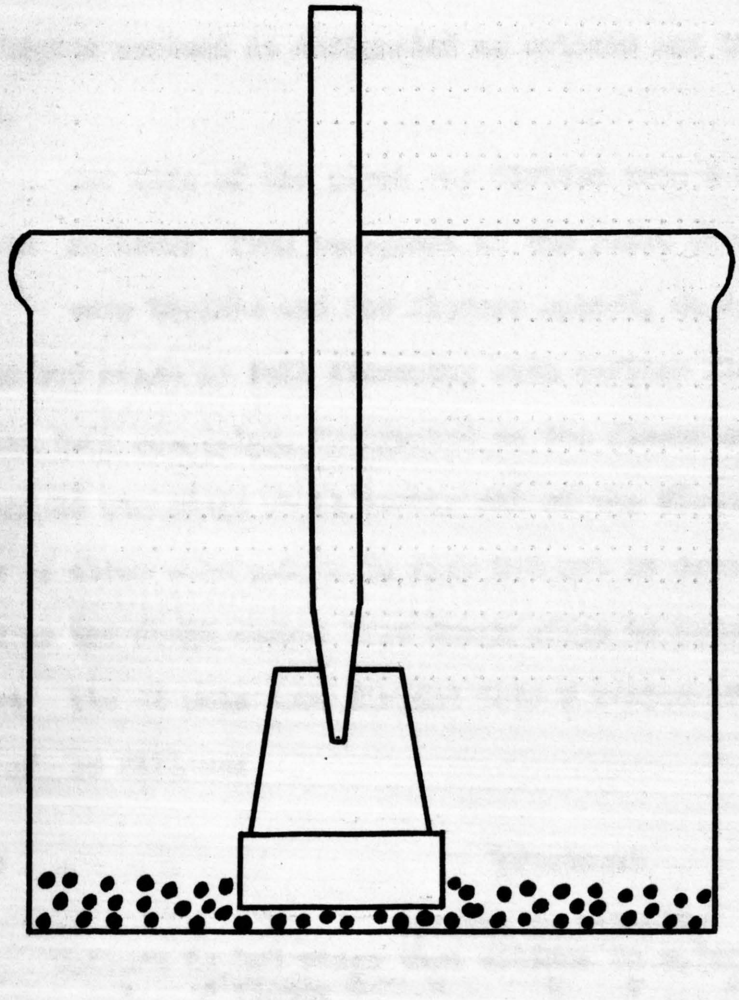
The invesitagation was made in the greenhouse of the Department of Agronomy, South Dakota State College, during the winters of 1929-30 and 1930-1931.

Pots Flax plants were grown in one-gallon glazed earthenware pots. A modification of Kiesselbach's (7) pot potometer was used for watering as shown in Figure 1. A 2-inch porous clay flower pot was placed in an inverted position in the bottom. A length of ½-inch glass tubing was drawn to a point where it would fit snugly in the drainage hole of the flower pot. It was made about 8 inches long so as to extend approximately 2 inches above the surface of the soil.

To equalize the weight of the pots and thus facilitate weighing, gravel was placed around the small flower pot to a depth of ½ inch. It also insured more rapid and better distribution of water. By placing a funnel in the open end of the glass tubing, water could be introduced into the soil from below. When the plants reached such a height as to necessitate the use of wire supports, the sub-irrigation was discontinued and the plants were surface watered.

Each pot had a 4.0 kg. of well pulverized and mixed soil placed in it and rain water added to the extent of 60% of water-holding capacity. The variety used for seed was Bison which was obtained from the breeding nursery. All pots were kept at 60% saturation for 7 days to insure all plants having an equal start. When the plants were 2-3 inches in heighth they were thinned down to 20 per pot for the first crop and 15 per pot for the next crop. The planting of an excess and then thinning made for better spacing and allowed the remaining plants to have an equal chance at the available moisture.

Figure 1 Diagram of Potometer Used



Soil The soil used is described as Barnes sandy loam. It has a water-holding capacity of 46%. Pots having 80% water-holding capacity had 1504 cc. rain water and those having 20% had 920 cc. water. Sander (16) working with Barnes sandy loam found that optimum growth was secured at 80% of the water-holding capacity and that the minimum amount necessary to produce seed was 20%. For convenience the higher content is designated as optimum and the lower one as minimum.

Stages In Plant Growth The life of the plant was divided into 4 stages as follows: from emergence to the point when many buds were visible and few flowers opened, designated as bud stage; from bud stage to full flowering with earlier flowers dropped and some few buds remaining, designated as the flower stage; from flower stage to the stage where nearly all of the flowers had set bolls some of which were mature in size but not in development, designated as the dough stage; from dough stage to maturity.

Arrangement and Treatment of Plants The 32 pots were divided into 8 series of 4 pots each as follows:

Series	Treatment
A	Optimum to Maturity
B	Optimum to bud stage then minimum to maturity
C	" " flower " " " " "
D	" " dough " " " " "
E	Minimum " bud " " optimum " "
F	" " flower " " " " "
G	" " dough " " " " "
H	Minimum to Maturity

Those series having the water content changed from optimum to minimum had water withheld until the lower content was reached. In some cases to prevent permanent wilting, small amounts of water were added during the transition period. Those changing from minimum to optimum had the full amount necessary to make the change added at one time.

Once each week from emergence to maturity the pots were weighed and sufficient rain water added to bring them to the required water content. During the cold weather water was added in midweek to bring them approximately to the required degree of saturation. During warm weather water was added each day and the required saturation obtained each week.

As near as possible the temperature of the greenhouse was kept at 65°F. by means of a thermostate and manually operated ventilators.

During the winter and during prolonged cloudy weather, artificial illumination was used to supplement sunlight. This was provided by a 500 watt lamp suspended about 3 feet above the plants.

When the plants were ripe, they were cut and allowed to dry thoroughly. The plant weight, seed weight, number of bolls, number of secondary branches, number of seeds per boll and weight of 100 seeds were determined for each pot. The oil content was determined for each series as a whole.

Figure 2 Effect of Various Moisture Treatments on the Growth Curve of Flax in 1929

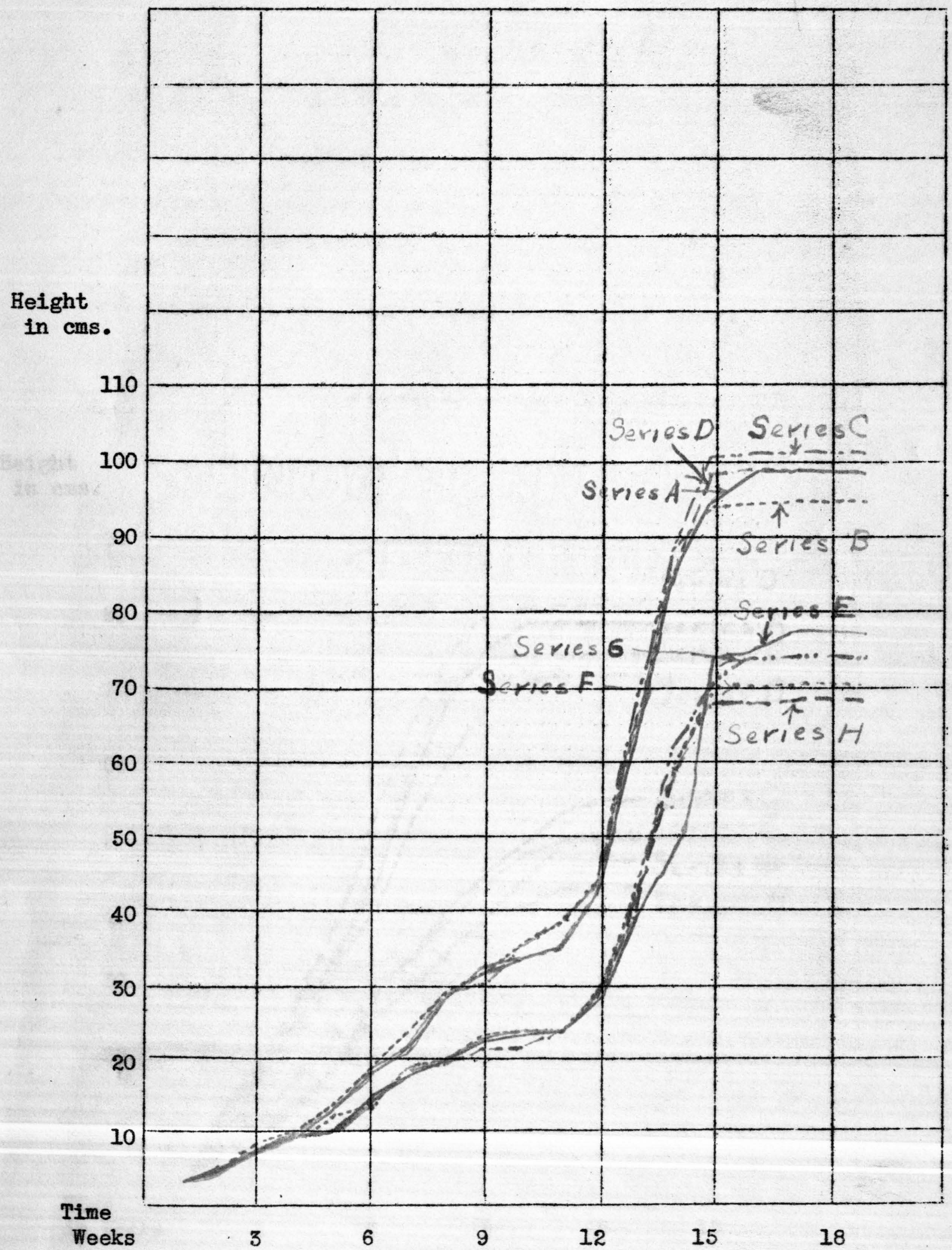
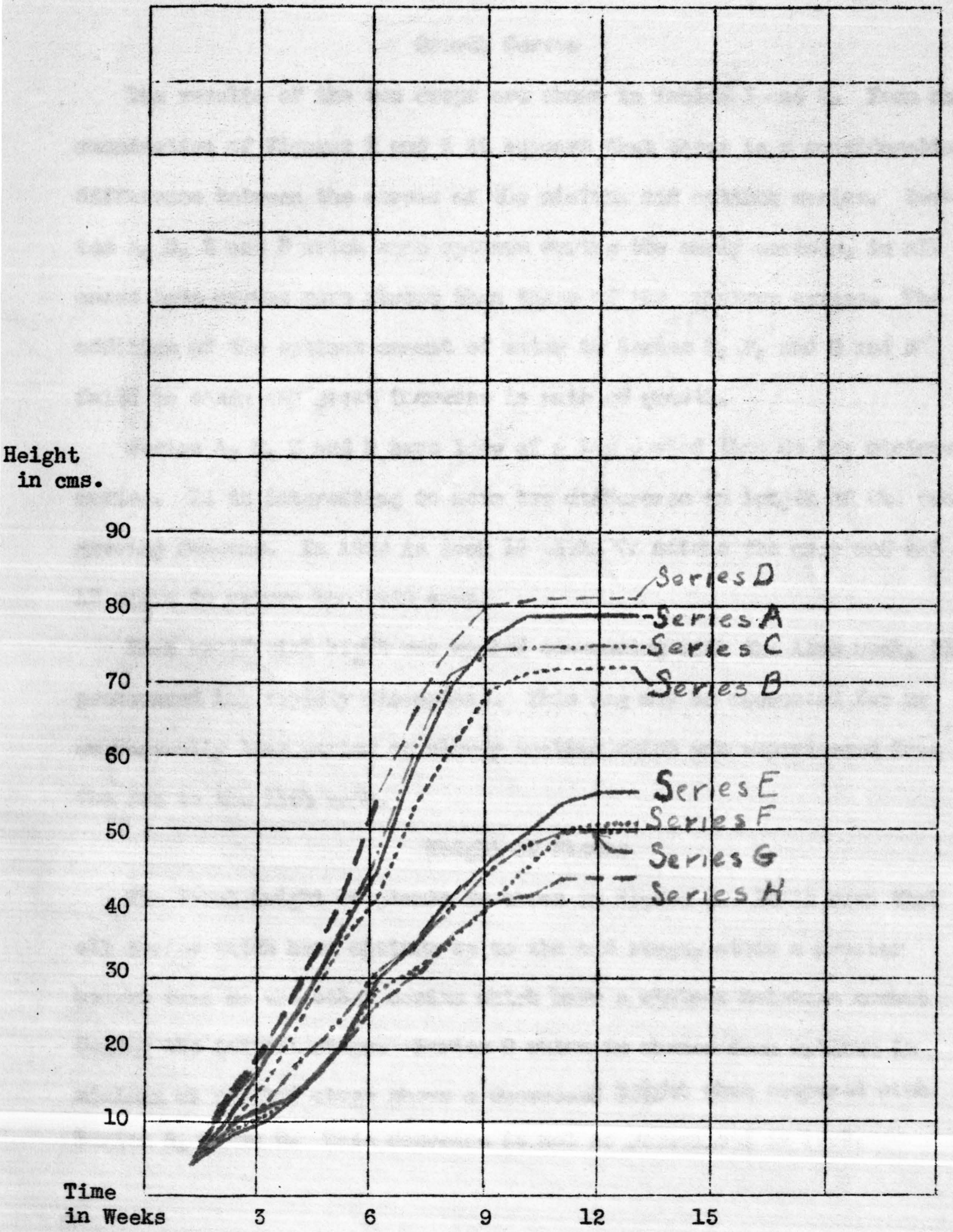


Figure 3 Effect of Various Moisture Treatments on the Growth Curve of Flax in 1930



EXPERIMENTAL RESULTS

Growth Curves

The results of the two crops are shown in Tables 1 and 2. From an examination of Figures 2 and 3 it appears that there is a considerable difference between the curves of the minimum and optimum series. Series A, B, C and D which were optimum during the early periods, in all cases have curves more abrupt than those of the minimum series. The addition of the optimum amount of water to Series E, F, and G and H faild to cause any great increase in rate of growth.

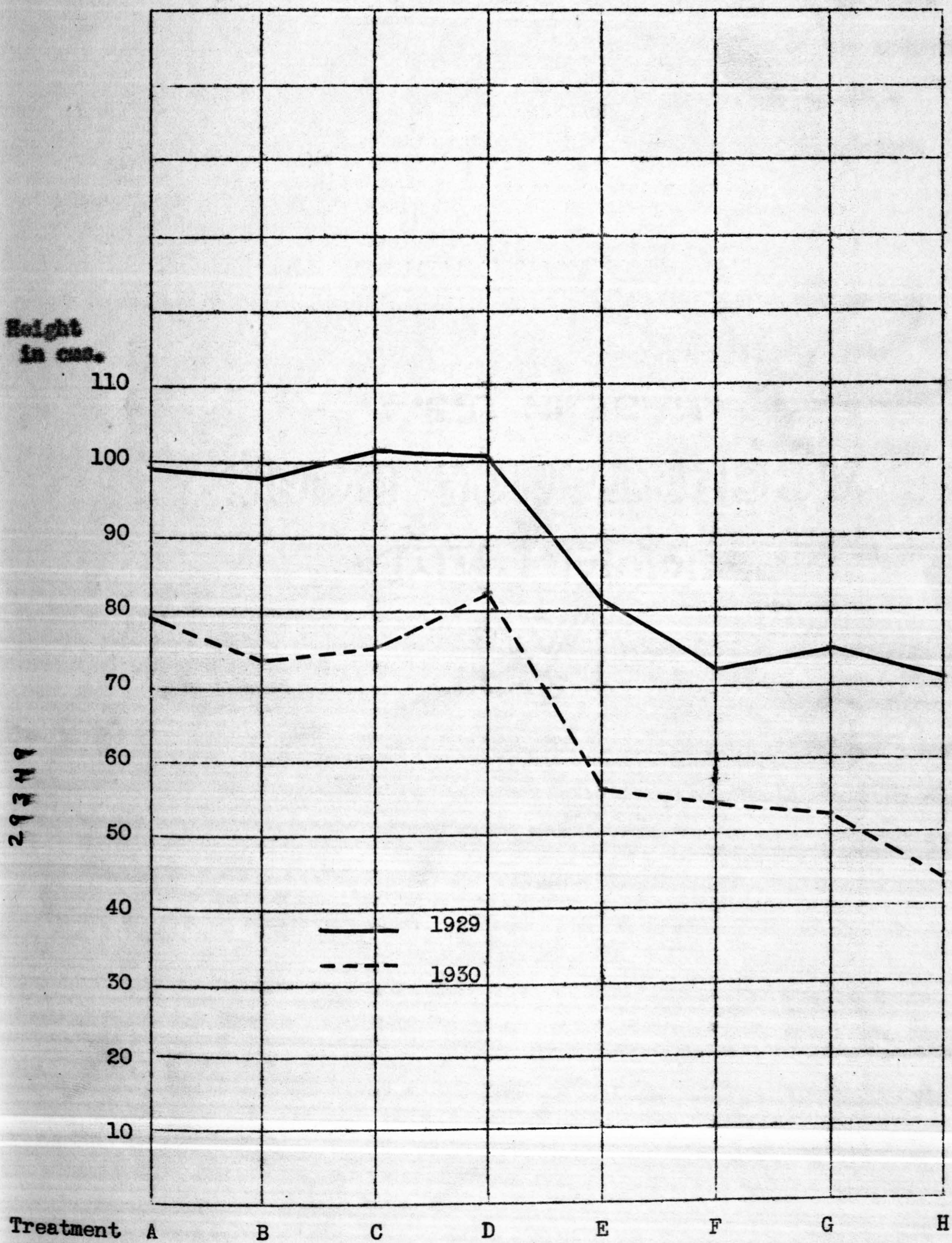
Series A, B, C and D have less of a lag period than do the minimum series. It is interesting to note the difference in length of the two growing seasons. In 1929 it took 19 weeks to mature the crop and but 13 weeks to mature the 1930 crop.

When artificial light was appied commencing with the 11th week, the pronounced lag rapidly disappears. This lag may be accounted for by an unusually long period of cloudy weather which was experienced from the 5th to the 11th week.

Height of Plants

The total height of plants is shown in Figure 4. It is seen that all series which have optimum up to the bud stage, attain a greater height than do the other series which have a minimum moisture content during the initial stage. Series B which is chance from optimum to minimum at the bud stage shows a decreased height when compared with Series A, C and D. This decrease is not so pronounced in 1929.

Figure 4 Effect of Various Moisture Treatments on the Height of Flax Plants for 1929 and 1930



Series D which is optimum to the dough stage experiences no dwarfing as a resut of the change.to minimum. Series E, F and G do not respond greatly with an increase in height as a result of the change from minimum to optimum. However, Series D which is continually minimum is the shortest in height.

Total Weight of Plants

It may be seen from Figure 5 that optimum moisture produces the greatest weight. When the change in moisture content from optimum to minimum occurs at the bud stage as in Series B, a pronounced detrimental effect is produced. If the change is delayed to either the flower or dugh stage it is much less severe. In fact Series D of 1930 had a total weight slightly greater than Series A which was optimum to maturity.

The series which are minimum in moisture content at the beginning never produce as large a dry weight as those having optimum moisture in the beginning. However, the earlier such change occurs, the greater the weight. Series E which has the moisture content increased at the bud stage is very close to Series B which is reduced from optimum to minimum at this stage.

Seed Weight per Pot

The seed weight per pot makes a rapid decline from Series A to Series C as shown in Figure 6 with little difference exhibited between B and C. If the change from optimum to minimum occurs at the dough stage as in Series D less harm is done as far as seed production is concerned.

Series E, F and G show a downward trend in seed weight as the increased water content is delayed from the bud stage up to the dough stage. A comparison of Series H and C show that little difference is

Figure 5 Effect of Various Moisture Treatments on the Total Weight of Flax Plants in 1929 and 1930

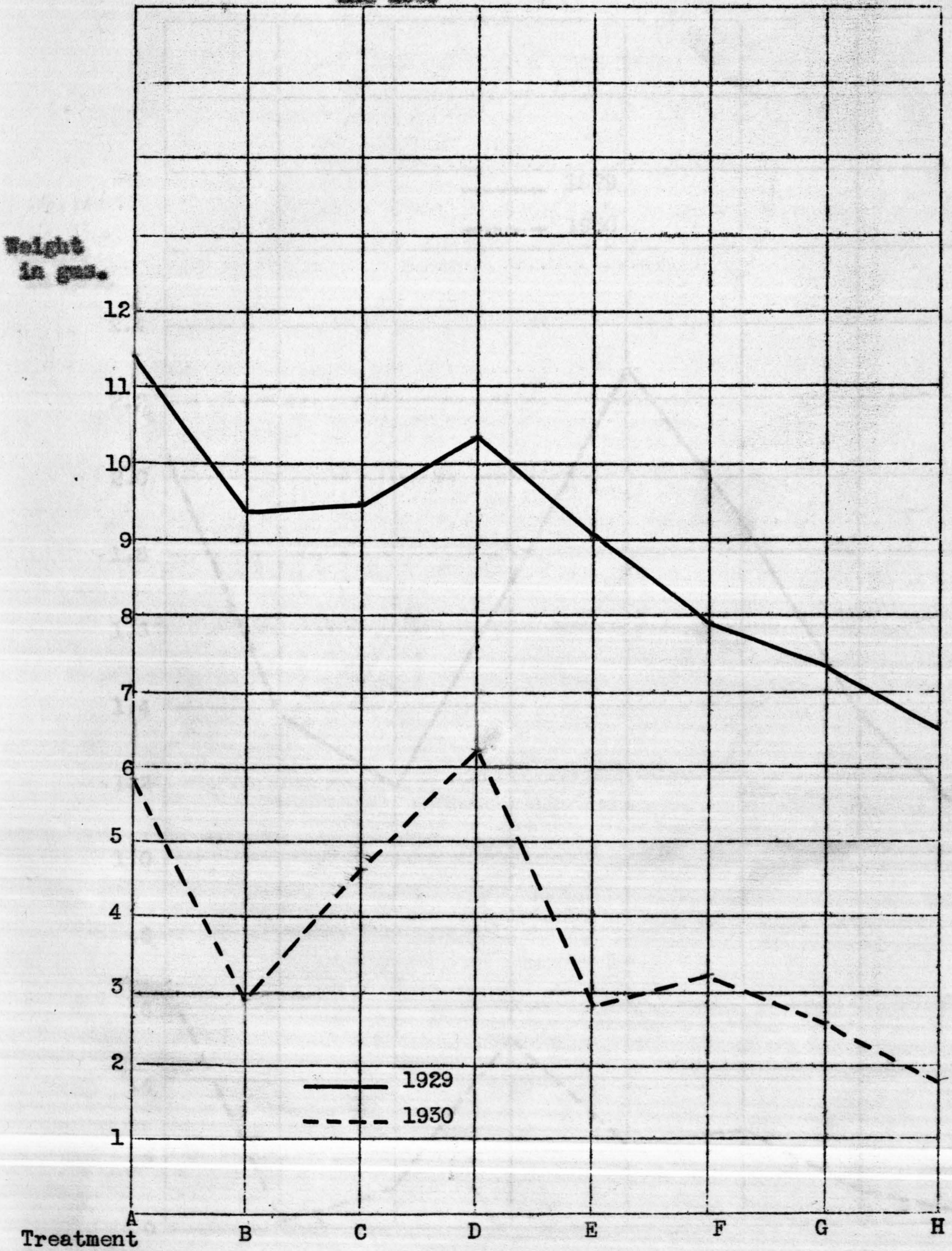
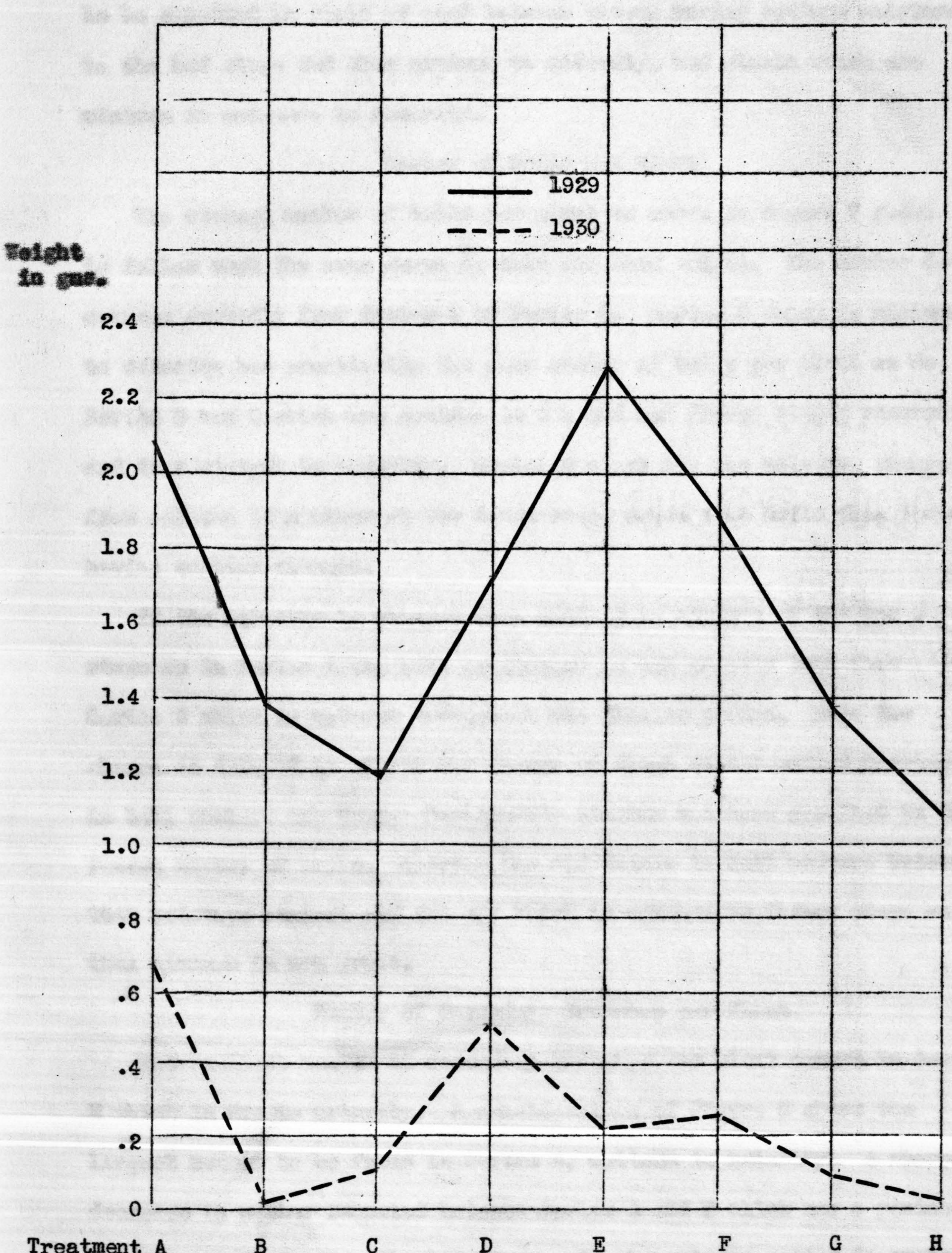


Figure 6 Effect of Various Moisture Treatments on the Seed Weight per Pot in 1929 and 1930



to be expected in yield of seed between plants having optimum moisture to the bud stage and then minimum to maturity, and plants which are minimum in moisture to maturity.

Number of Bolls per Plant

The average number of bolls per plant as shown in Figure 7 seems to follow much the same curve as that for seed weight. The number decreases markedly from Series A to Series C. Series D which is minimum to maturity has practically the same number of bolls per plant as do Series B and C which are optimum to the bud and flower stages respectively and then minimum to maturity. Series D which has the moisture changed from optimum to minimum at the dough stage shows more bolls than those having earlier changes.

If the moisture is changed from minimum to optimum at the bud stage as in Series E the boll production is not greatly less than Series A which is optimum throughout the growing period. When the change is delayed to either the flower or dough states marked decreases in boll numbers are seen. Continually minimum moisture resulted in the fewest number of bolls. However the difference in boll numbers between that moisture content and the one which is optimum to flower stage and then minimum is not great.

Number of Secondary Branches per Plant

The smallest number of secondary branches per plant occurs in Series H which is dry to maturity. A consideration of Figure 8 shows the largest number to be found in Series A, optimum to maturity. A sharp decrease in number is noted between Series A and B which has a minimum moisture content after the bud stage. If the optimum period is prolonged to the flower or dough stage before the change occurs little difference

Figure 7 Effects of Various Moisture Treatments on the Average Number of Bolls per Plant in 1929-1930

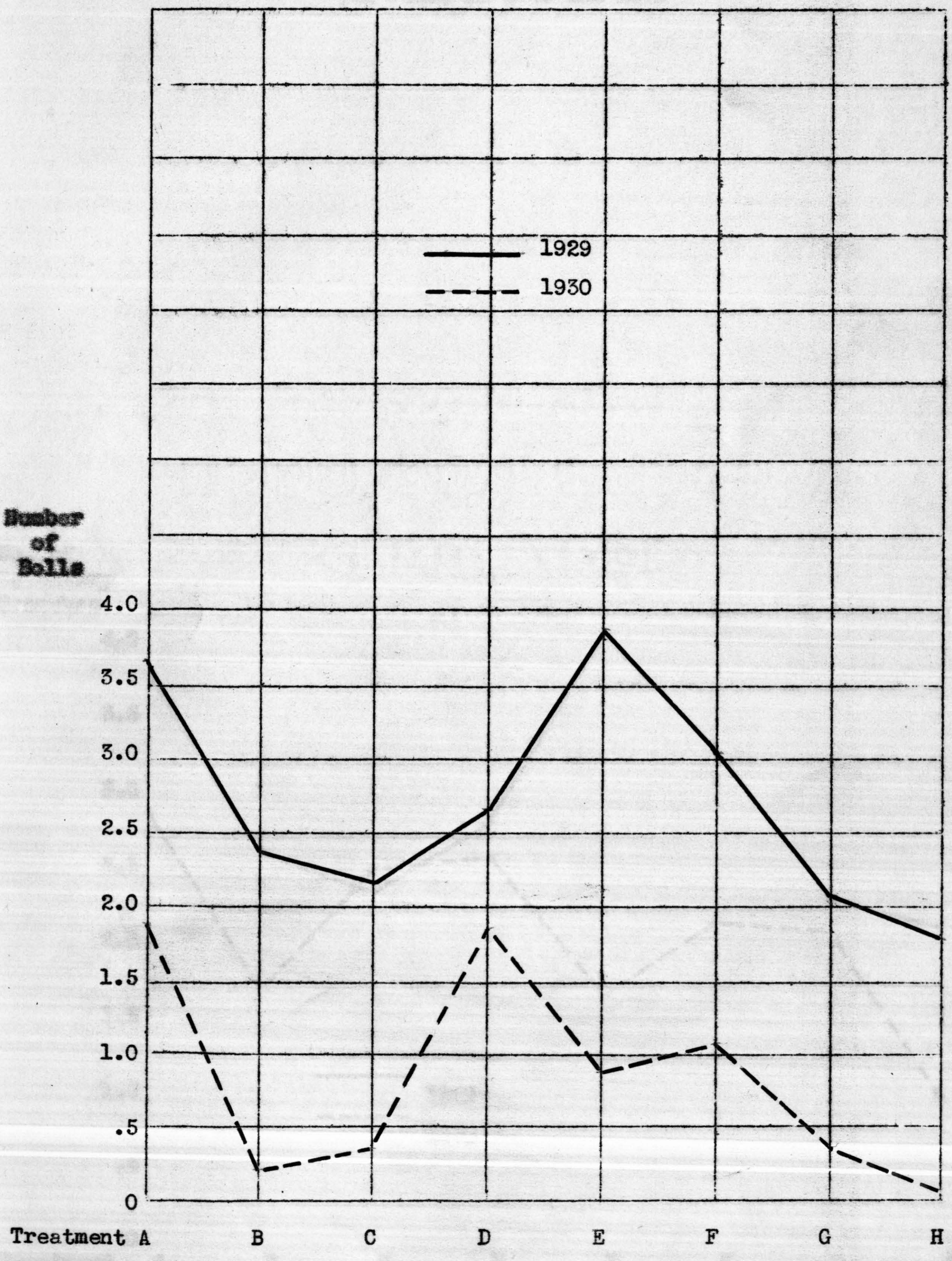
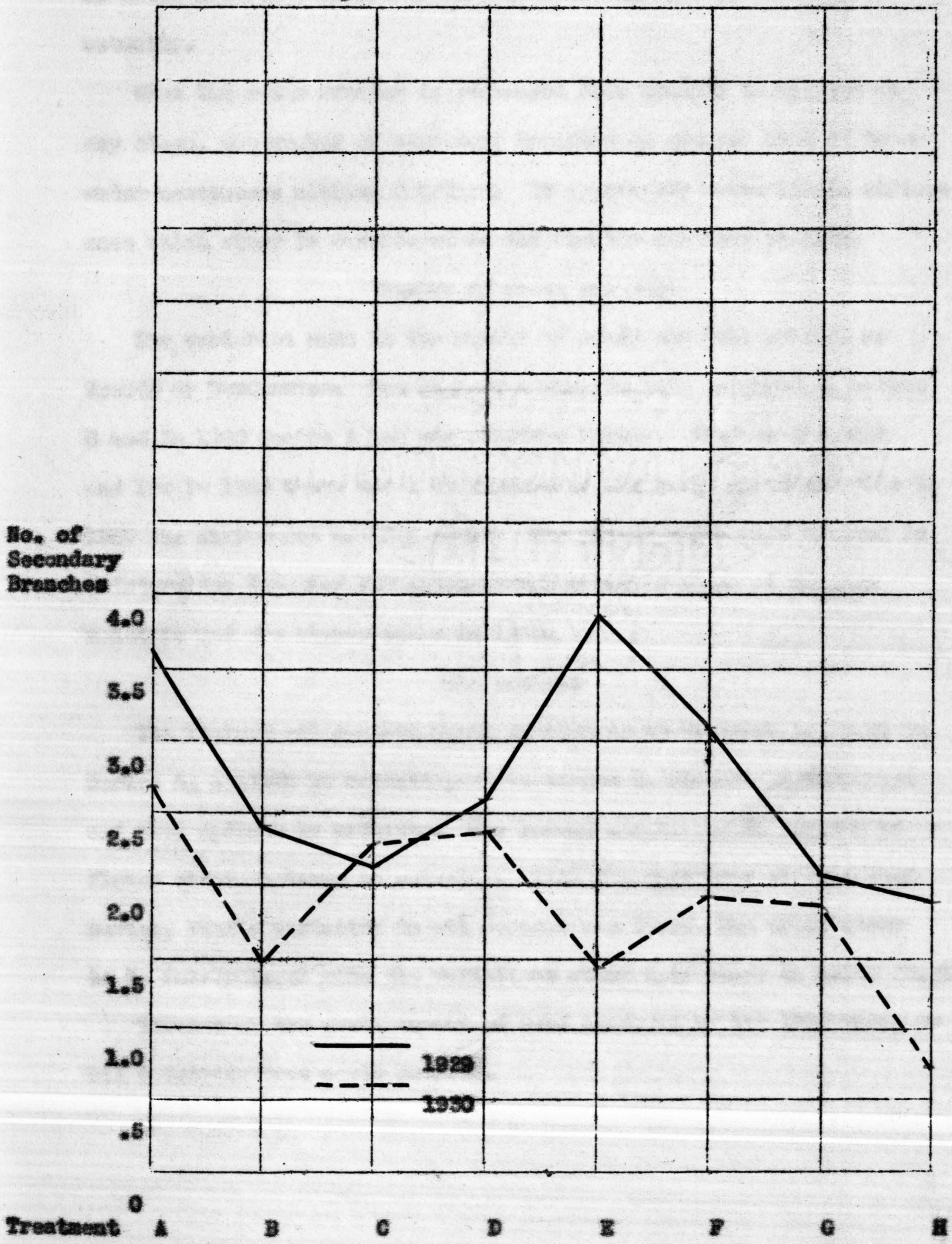


Figure 8 Effect of Various Moisture Treatments on the Number of Secondary Branches per Plant in 1929 and 1930



is noted between such plants and those having optimum moisture to maturity.

When the water content is increased from minimum to optimum at any stage, the number of secondary branches is greater than of those under continuous minimum moisture. It apparently makes little difference which stage is considered as the results are very similar.

Number of Seeds per Boll

The variation seen in the number of seeds per boll exhibit no trends or tendencies. The highest number in 1929 occurred in Series G and in 1930 Series A had the greatest number. Between the high and low in 1929 there was a difference of .64 seeds per boll while in 1930 the difference was 2.0 seeds. The plants which were optimum in moisture for 1930 had the greatest number while those of minimum moisture had the higher value in 1929.

Oil Content

The highest oil content noted in 1929 is 35.6% which is found in Series A, optimum to maturity, and in Series G, minimum to bud stage and then optimum to maturity. The lowest was Series F, minimum to flower stage, optimum to maturity. With the exception of this last series, little variation in oil content was found. The trend seems to be fairly level with the variations about 0.2% above or below 35.2%.

Because of the small amount of seed produced by the 1930 crop, no oil determinations could be made.

Weight of 100 Seeds

The weight of 100 seeds of each of the various treatments varies considerably. Much variation was also noted between the same treatment for the two years. No definite trends can be seen although the variations for the 1929 crop fall within very narrow limits. A point of interest is the fact that for both years Series C, optimum to flower stage and minimum to maturity, showed the least weight for 100 seeds.

Seed Weight per Plant

The seed weights per plant correspond very closely to the seed weight per pot. This is due to the uniformity in number of plants per plot. The curve of seed weight per pot and per plant almost coincide indicating that the correlation is extremely high. Any statements regarding seed weight per pot would be applicable to seed weight per plant.

Number of Seeds per Pot

The curve of the number of seeds per pot is very similar to the curve of the seed weight per pot, because of the slight variation in weight of 100 seeds. Any variations existing are not great enough to be significant.

Weight of Individual Plant

The weight of individual plants for the various treatments has a curve which, with one exception, almost coincides with the curve for the total weight of plants. Statements or conclusions regarding total weight of plants would equally apply to weight of individual plants.

DISCUSSION

From the foregoing results it is evident that nearly all phases of development are influenced to a greater or lesser degree by the amount of available water during the different periods of growth. If we may consider that flax under field conditions reacts to moisture in similar ways, then some conclusions which we may draw may be considered applicable.

Perhaps the most significant point to be noted is the difference which exists between the heights of plants receiving optimum moisture early and those which receive it later. Series A, B, C, D which received optimum moisture up to the bud stage, as a whole, exceed in height those which were dry to the bud stage. Though the heights of each group for the two years varied somewhat, the difference is quite uniform being approximately 25 cm. Preul (14) in working with wheat found substantially the same results. He noted that a plentiful supply of water up to the shooting stage produced normal height. This would seem to indicate that if rainfall is sufficient up to the bud stage, little difficulty might be expected in harvesting due to lack of height.

Of the series which received optimum moisture in the early stages, Series B, which had the moisture decreased to the minimum at the bud stage, attained the least height. This is in line with the results obtained by Miller and Duley (11) who found that corn plants subjected to the same treatment as above were but 2 inches taller than those having minimum moisture all the time. Such a difference in height may be due to the fact that at the bud stage, the rate of growth was still very rapid. When the flower stage was reached, the rate of growth was much slower and most of the height had been attained.

Of the group which had the minimum amount of moisture during the early stages and were later changed to the optimum, Series F, changed at the bud stage reached the greatest height. The optimum moisture was apparently received while the plant could still make some use of it in increasing its height. However, the difference between it and the one receiving minimum to maturity was only 10 cms. Preul (14) noted also that if the early growth of wheat had little moisture, no amount later could compensate for the previous deficiency. Hence insofar as height is concerned, little increase in height may be expected from rainfall which occurs as late as the bud stage.

Yield is one of the factors which influence the choice of a crop. From the practical standpoint a consideration of the effect of moisture on such a yield is most important. Differing from height of plants, there is no evidence of a well defined grouping as the result of moisture changes at various physiological stages. The series which received optimum moisture to maturity had the highest yield. The next in point of yield is Series E which had the minimum amount to the bud stage and then optimum to maturity. Miller and Duley (11) found this to be true in the case of corn while Preul (14) actually had a better yield from the plants subjected to an early dry period than from those which were optimum to maturity. Hence insofar as optimum moisture is concerned, a lack of it up to the bud stage is less detrimental than at any other time.

When the change from minimum to optimum is postponed to the flower stage, the yield is greatly reduced, approaching closely that of the series which is minimum to maturity. The plants are unable to make the fullest use of the water in increasing the yield.

If the drouth is delayed until the dough stage the yield is reduced but to a lesser degree than in the above case. Plants under this treatment wilt rapidly and soon lose all but the top leaves, all the water seeming to go for seed production. This is borne out by the slight increase in height which is noted after such change.

The smallest yield occurs in those plants which have the minimum amount of moisture to maturity. Harris (5) working with wheat and Seelhorst (18) with oats found substantially the same results.

The number of secondary branches per plant is affected to some extent by varying moisture contents but the effects are quite variable. Of the group which was optimum during the early stages Series B which was changed from optimum to minimum at the bud stage, had the fewest number of secondary branches. Series A, optimum to maturity, had the greatest number. Seelhorst (18) found somewhat the opposite condition with regard to the number of branches per panicle of ats as shown by the following results:

Lot	Treatment	Branches per Panicle
A	Minimum to maturity	4.6
B	Minimum to shooting stage, then optimum to maturity	5.0
C	Optimum to shooting " " minimum " "	6.2
D	Optimum to maturity	6.3

The flax curves for the two years agree however with the above results in one respect that minimum moisture to maturity produces the fewest number of secondary branches. Because of the variability in the results, no definite trends or tendencies can be noted in any of the intermediate moisture treatments.

One might assume that boll formation would be closely associated with the number of secondary branches because the bolls are borne on such branches. Such however is apparently not the case. The highest degree of correlation exists between the yield and the number of bolls. As the number of bolls increases or decreases, the yield follows very closely.

Series A which was optimum to maturity had the highest number of bolls closely follwed by Series E which was minimum to bud stage then optimum to maturity. These are the same results as were obtained in the case of yield. Those series in which the change was made from optimum to minimum at the flower and dough stages had the boll production markedly decreased. The same holds true of these series in which the change from minimum to optimum occured at these stages.

When the changes were made in moisture content from optimum to minimum numbers of bolls and flowers aborted. Those flowers and bolls which survived the change produced matured bolls. The number maturing is closely associated with the amount of water, the bud stage being the critical period. If the drouth occurs sooner or moisture increased later than this stage, fewer bolls are produced.

From the practical viewpoint the total weight of plants is not of extreme importance in itself. It is interesting to note however its relation to the yield of seed. For 1929 and 1930 the correlation of these factors was .45 ± .12 and .80 ± .08 for the two years respectively. These figures are indicative to a certain extent but the large probable error in 1929 makes its importance negligible.

The greatest variation which occurred between plant weight and seed weight is found in Series B and C which are reduced from optimum to minimum moisture at the bud and flower stages respectively. With series the weight of plants held up remarkably well while the seed weight approached minimum. Possibly all the available water was used to keep the vegetative portion of the plant alive at the expense of seed formation. With those series in which the water was minimum at first and later changed to optimum, the plants apparently divided the available water between the vegetative parts and the reproductive parts. This is borne out by the degree to which the curves for total weight and seed weight coincide as shown in Fugures 5 and 6.

The number of seeds per boll gave results contrary to expectation. Sander (16) with flax found some variation depending on the water available. Up to and including 30% moisture he found a steady increase in the number of seeds per boll. Dillman (2) at Mandan, North Dakota found that a severe drouth caused many of the flowers to blight without forming bolls, and to reduce the number of seeds per boll.

The writer, however, noticed little variation in the number of seeds pdr boll of the flax under different moisture contents. The 1929 crop had the most seeds per boll in that series which had the minimum amount of water to maturity. The following year the variation is in the other direction with the greater number of seeds per boll occurring in Series A wich was moist to maturity.

Constant moisture of any degree may have a different effect on the seeds per boll than a varying amount. At the same time it is possible that some factor other than soil moisture might be responsible for the differences noted. Temperature, humidity and other environmental conditions might play important parts in the number of ovules fertilized.

Seelhorst (18) working on the water relationships of oats found that plants which were continually dry had a slightly greater weight per 100 seeds than did plants having an ample supply of moisture. He attributed his results to the fact that plants on low moisture set no more kernels than they were able to mature, hence their good weight.

Harris (5) and Gain (4) both secured the same results, Harris working with wheat. He found that kernels from the plants grown under dry conditions were hard and vitreous while those from plants having plenty of moisture were starchy in nature.

Of the flax results that of the 1929 crop was similar to those of Seelhorst. Series H which was dry to maturity had the greatest weight per 100 seeds. With the 1930 crop however, the greatest weight was found for the plants under optimum moisture to maturity. There is too much variation to allow any conclusion to be drawn regarding the effect of varying moisture contents on weight of 100 seeds.

SUMMARY

1. In this study, the effect of varying the moisture supply at different periods in the growth of flax plants was determined under greenhouse conditions.

2. The soil used was Barnes sandy loam of average fertility. It had a moisture holding capacity of 46% on the air dry basis.

3. Flax plants were grown in one gallon pots containing 4 Kg. of dry soil. There were 20 and 15 plants per pot for the 1929 and 1930 crops respectively.

4. The growing period was divided into 4 stages from emergence to bud stage; from bud stage to flower stage; from flower stage to dough stage, from dough stage to maturity. Changes in water content were made from optimum (60% to minimum (20%) and vice versa at all stages.

5. At maturity the plants were harvested and dried. Total plant weight, seed weight, number of bolls, number of secondary branches, number of seeds per boll, weight of 100 seeds, and oil content were determined.

6. Plants having optimum moisture for at least the first stage had the greater height. Those which were minimum for the first period were shorter by about 25 cms., regardless of the amount of water applied or the stage of application.

7. When the drouth occurred during the first stage, the total weight was decreased but the seed weight, number of bolls and number of secondary branches were nearly as great as those having optimum moisture to maturity.

8. Varying the water content had little effect on the number of seeds per boll.

9. The weight of 100 seeds was not affected by varying moisture contents.

10. Varying the moisture supply had no significant effect on oil content.

Table 2 EFFECT OF VARIOUS MOISTURE TREATMENTS ON DEVELOPMENT, YIELD AND QUALITY OF FLAX IN 1929

Treatment	Pot No.	No. of Plants per Pot	Av. Ht. cms	Wt. of Plants gms.	Wt. per Plant gms.	Wt. of 100 seeds gms.	Av. No. Sec. Br. per plant	Av. No. Bolls per plant	Seed Wt. per Pot gms.	Seed Wt. per plant gms.	No. Seeds per pot	No. Seeds per boll	Oil Content
		DEVELOPMENT							YIELD				QUALITY
Optimum to maturity	1	20	100	11.30	.565	.507	3.65	4.00	2.12	.106	416	5.22	
	2	22	100	11.5	.515	.483	3.68	4.27	2.51	.114	519	5.52	
	3	25	94	11.5	.460	.461	3.40	2.96	1.44	.057	312	4.19	
	4	21	101	11.4	.542	.505	3.61	3.36	2.16	.103	427	6.01	
	Av.	22.0	98.75	11.37	.520	.489	3.58	3.65	2.12±.26	.095	419	5.23	35.6
Optimum to bud stage, minimum to maturity	5	21	101	9.2	.436	.484	3.09	2.14	1.10	.052	227	5.04	
	6	21	93	8.9	.423	.516	2.47	2.47	1.41	.067	275	5.25	
	7	19	93	8.9	.468	.514	2.47	2.42	1.40	.073	272	5.81	
	8	22	102	10.0	.454	.502	3.68	2.62	1.71	.078	340	5.86	
	Av.	20.7	97.2	9.25	.446	.504	2.93	2.41	1.40±.15	.067	276	5.51	35.5
Optimum to flower stage, minimum to maturity	9	23	102	10.1	.439	.519	3.39	1.73	1.08	.047	208	5.20	
	10	23	99	8.7	.378	.469	3.50	2.30	1.29	.056	275	5.19	
	11	21	107	9.8	.466	.489	4.04	2.47	1.46	.069	298	5.75	
	12	20	101	9.0	.450	.469	4.15	2.15	1.01	.050	215	4.78	
	Av.	21.7	102.2	9.4	.433	.486	3.72	2.16	1.21±.12	.055	249	5.22	35.0
Optimum to dough stage, minimum to maturity	13	22	101	9.9	.450	.429	3.27	2.22	1.30	.059	303	6.18	
	14	24	99	9.5	.395	.503	2.87	2.91	1.50	.062	370	4.80	
	15	22	103	10.7	.486	.540	3.09	2.81	2.00	.090	296	5.28	
	16	26	102	11.0	.452	.516	3.34	2.84	1.91	.075	370	5.00	
	Av.	23.5	101.2	10.27	.446	.497	3.14	2.69	1.68±.19	.071	335	5.31	35.1
Minimum to bud stage, optimum to maturity	17	21	82	9.5	.452	.503	3.61	4.00	2.29	.109	453	5.41	
	18	22	80	8.4	.381	.519	3.09	3.81	2.26	.102	450	5.22	
	19	23	82	8.5	.370	.510	[illegible]	3.56	2.20	.095	431	5.35	
	20	22	83	9.8	.445	.504	[illegible]	3.72	2.33	.105	462	5.62	
	Av.	22.0	81.7	9.05	.412	.509	3.48	3.77	2.27±.03	.103	447	5.38	35.1
Minimum to flower stage, optimum to maturity	21	21	73	7.2	.342	.501	2.33	2.71	1.56	.074	311	5.45	
	22	22	71	8.3	.377	.518	3.13	3.18	2.14	.097	415	5.90	
	23	21	73	8.4	.400	.503	3.19	3.38	2.19	.103	433	6.09	
	24	21	73	7.8	.371	.494	3.04	3.04	1.83	.087	370	5.78	
	Av.	21.2	72.5	7.92	.372	.504	2.92	3.08	1.93±.17	.090	382	5.80	34.4
Minimum to dough stage, optimum to maturity	25	22	78	6.8	.309	.484	3.36	1.86	1.23	.056	254	6.19	
	26	23	77	7.7	.334	.488	3.15	2.30	1.53	.066	313	5.90	
	27	23	74	7.4	.321	.535	2.75	2.26	1.57	.068	293	5.63	
	28	22	73	7.4	.336	.500	2.61	2.15	1.35	.061	270	5.74	
	Av.	22.5	75.5	7.32	.325	.502	3.0[illegible]	2.14	1.42±.09	.063	283	5.86	35.6
Minimum to maturity	29	22	72	6.8	.309	.506	2.00	1.81	1.24	.056	245	6.12	
	30	22	70	6.3	.286	.516	2.59	2.18	1.25	.057	242	5.04	
	31	22	72	6.0	.272	.516	2.09	1.40	.93	.043	164	5.93	
	32	22	73	7.0	.318	.513	2.86	1.77	1.13	.051	220	5.64	35.2
	Av.	22.0	71.7	6.52	.296	.513	2.38	1.79	1.14±.08	.052	223	5.68	

Table 2 EFFECT OF VARIOUS MOISTURE TREATMENTS ON DEVELOPMENT, YIELD AND QUALITY OF FLAX IN 1930

		DEVELOPMENT							YIELD				QUALITY
Treatment	Pot No.	No. of Plants per Pot	Av. Ht. cms.	Wt. of Plants gms.	Wt. per plant gms.	Wt. of 100 seeds gms.	Av. No. Sec. Br. per plant	Av. No. Bolls per plant	Seed Wt. per pot gms.	Seed Wt. per plant gms.	No. Seeds per pot	No. Seeds per boll	Oil Content
Optimum to maturity	1	15	82	6.0	.40	.43	3.4	1.9	.67	.044	155	5.3	*
	2	18	80	6.9	.38	.46	2.2	1.8	.78	.042	164	5.0	
	3	16	83	6.1	.38	.41	2.3	2.0	.78	.048	185	5.8	
	4	14	75	4.2	.30	.51	2.8	1.9	.74	.053	146	5.6	
	Av.	15.8	79.5	5.8	.37	.45	2.7	1.9	.73 .02	.047	162	5.4	
Optimum to bud stage, minimum to maturity	5	16	60	2.2	.14	.20	1.4	.1	.01	.001	5	5.0	*
	6	16	74	2.7	.17	.59	1.3	.3	.02	.001	13	3.3	
	7	14	78	3.0	.21	—	1.9	.0	.00	.000	0	—	
	8	14	80	3.8	.27	.31	1.4	.2	.05	.004	16	5.3	
	Av.	15.0	73.0	2.9	.20	.37	1.5	.2	.02 .01	.002	8.5	4.5	
Optimum to flower stage, minimum to maturity	9	16	75	5.0	.31	.29	2.1	.3	.06	.004	21	5.3	*
	10	17	80	6.0	.35	.29	2.1	.5	.15	.008	51	5.7	
	11	15	74	3.8	.25	—	2.4	.1	.00	.000	0	—	
	12	14	72	3.5	.25	.29	2.6	.4	.06	.004	21	4.2	
	Av.	15.5	75.0	4.6	.29	.29	2.3	.3	.07 .04	.004	23	5.1	
Optimum to dough stage, minimum to maturity	13	16	87	6.8	.43	.41	2.3	1.3	.38	.024	92	4.4	*
	14	14	83	6.7	.48	.37	2.4	2.4	.58	.041	157	4.6	
	15	17	81	6.1	.36	.37	2.5	1.9	.67	.039	183	5.7	
	16	15	77	5.2	.35	.35	2.3	1.7	.39	.026	112	4.3	
	Av.	15.5	82.0	6.2	.42	.38	2.4	1.8	.51 .06	.033	136	4.8	
Minimum to bud stage, optimum to maturity	17	15	54	2.5	.17	.29	1.6	.4	.08	.005	28	4.7	*
	18	15	56	3.0	.20	.40	1.0	.8	.19	.013	48	4.0	
	19	16	56	3.0	.13	.35	1.6	.9	.24	.015	59	4.9	
	20	11	60	2.8	.25	.44	1.5	1.5	.39	.035	89	5.6	
	Av.	14.3	56.5	2.8	.20	.37	1.4	.9	.23 .06	.017	58.5	4.8	
Minimum to flower stage, optimum to maturity	21	16	54	3.5	.22	.22	2.0	1.2	.21	.013	94	4.9	*
	22	14	55	3.3	.24	.42	1.9	1.3	.35	.025	83	4.6	
	23	17	53	3.0	.18	.33	1.9	.7	.17	.010	52	4.3	
	24	17	53	2.8	.16	.38	1.6	1.0	.25	.015	69	4.1	
	Av.	16.0	54.0	3.2	.20	.33	1.9	1.1	.25 .05	.016	74.5	4.5	
Minimum to dough stage, optimum to maturity	25	15	53	3.0	.20	.40	1.5	.7	.17	.011	43	3.9	*
	26	15	54	2.5	.17	.31	1.9	.7	.15	.010	48	4.4	
	27	16	56	2.1	.13	—	2.1	.0	.00	.000	0	—	
	28	16	50	2.7	.17	.29	1.8	.3	.05	.003	17	3.4	
	Av.	15.5	53.0	2.6	.17	.33	1.8	.4	.09 .05	.006	27	3.9	
Minimum to maturity	29	15	42	1.9	.13	—	1.1	.0	.00	.000	0	—	*
	30	14	50	2.2	.16	.33	.6	.4	.07	.005	21	3.5	
	31	17	42	1.6	.09	—	.3	.0	.00	.000	0	—	
	32	15	42	1.5	.10	—	.6	.0	.00	.000	0	—	
	Av.	15.3	44.0	1.8	.12	.33	.7	.1	.02 .02	.001	5.3	3.5	

* Sufficient seed lacking for determination

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