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Growth of cucumber and tomato seedlings the first few days after emergence.

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Growth of Cucumber and Tomato Seedlings the first few days after emergence.

S.A. Tooze

1 Introduction

In the past 2 years experiments have been conducted with young cucumber and tomato plants to determine the relationship between light and growth. Plants were grown from emergence to approx. 10 g fresh weight, with the first sample usually being made on the day of emergence. The second sample was made 3-7 days later depending on the time of the year and the length of the growth period to 10 g. The final growth analysis was based on the fresh and dry weight as well as leaf area increases (Tooze and Klapwijk, 1985). This was based on the assumption that for young plants the Relative Growth Rates (RGR) would result in approximately the same values. De Lint and Klapwijk (1974) concluded that fresh weight could be used to determine dry weight production of both the leaves and shoots. Their measurements began, however, at 1 g fresh weight which means that the plants were already several days old when the first measurement was made.

When the (RGR) were determined at the end of these experiments for fresh and dry weight and leaf area, the fresh weight RGR were usually as much as 10% higher than dry weight and leaf area RGR. If the RGR values were determined while excluding the first sample on the day of emergence the RGR values were quite similar. The purpose of these experiments was to more accurately measure the growth during the first few days after emergence to determine at what point in time the growth curves become similar. And also to determine how much the first samples deviate from the rest for fresh weight and leaf area.

2 Materials and Methods

Seeds of tomato cv 'Abunda' and cucumber cv 'Uniflora D' were sown in trays filled with potting compost. The trays were placed in a sowing table (25 °C) until emergence (5 days for tomato and 4 days for cucumber). In three experiments with cucumber, plants were harvested twice daily at 8.30 and 16.30 for 5 consecutive days. In 2 additional experiments plants were harvested thrice daily at 8.30, 12.30 and 16.30 for 2 consecutive days. With the tomato plants 1 experiment was conducted for 5 days, 1 for 3 days and 2 experiments for 2 days. The sampling times for tomato were the same as with cucumber. With the second experiment with cucumber the sowing date corresponded with the sowing date of a light reduction experiment. The control data from that experiment was used to provide growth data for the period to 10g fresh weight. The plants were harvested just below the cotyledons using 20 to 30 plants per sample. The leaf area measurements were made using a LI-COR area meter.

3 Results

3.1 Tomato

3.1.1 Results from the different experiments

The fresh and dry weight, % dry weight and leaf area for each experiment are given in appendix 1. The variation in fresh weight for the first sample is most likely due to variation in time between germination and sampling. Later variations in weight and leaf area can probably be attributed to experimental conditions. In general the emergence weights (9.33-13.1 mg) are one-tenth that of the cucumber. In experiments 1 and 4 the fresh weight actually show a

slight decrease during the first day after emergence. The dry weight also decreases slightly in all of the experiments except experiment no. 2. The % dry weight is quite high the first day of emergence (11.2-17.7), but decreases quite sharply by the second day. By the third day the the % dry weight is fairly stable (6.6-7.5). The growth parameters expressed as % of the day before for each experiment are given in Table 1. The leaf area increases between days 1 and 2 are quite high for experiments 3 and 4. After day 2 the leaf area increases less and less. The same is true for fresh weight, even though the initial increase between days 1 and 2 are smaller. The dry weight increases are much less than for fresh weight and leaf area initially, but the increases become greater after day 2.

Table 1. The fresh and dry weight and leaf area of tomato plants in % of the day before. Day 1 is the first day after emergence.

Experiment	Day no.			
	%			
1 (15-19 July)	1-2	2-3	3-4	4-5
fresh wt.	113	206	168	129
dry wt.	84	116	197	122
leaf area	--	306	190	148
2 (24-26 July)				
fresh wt.	180	186		
dry wt.	132	154		
leaf area	--	235		
3 (1-2 Aug.)				
fresh wt.	157			
dry wt.	112			
leaf area	233			
4 (27-28 Aug.)				
fresh wt.	120			
dry wt.	105			
leaf area	349			

3.1.2 Fresh and dry weight increases for tomato between the first and second day after emergence.

Similar experiments were conducted with tomato by Klapwijk and van Beek (1972). In their experiments seeds were sown several times from October to April and the fresh and dry weight were determined during the first two days of growth. The effect of season on growth immediately following emergence can also be seen (Fig. 1). The fresh and dry weight on day 2 as percent of day 1 is plotted against the sowing date. As with our experiments the fresh weight increases between days 1 and 2 are greater than the dry weight increases. The fresh weight is also more greatly affected by season decreasing from 200 % in the fall and spring to 50 % in the winter. The dry weight on the other hand decreases from 40 % in the fall and spring to little or no increase in the winter. Because of the relatively low fresh weight gain in the winter the % dry matter is higher during days 1 and 2 in the winter than during the rest of the year.

Alapwisk and
U. B. Cole (1972)

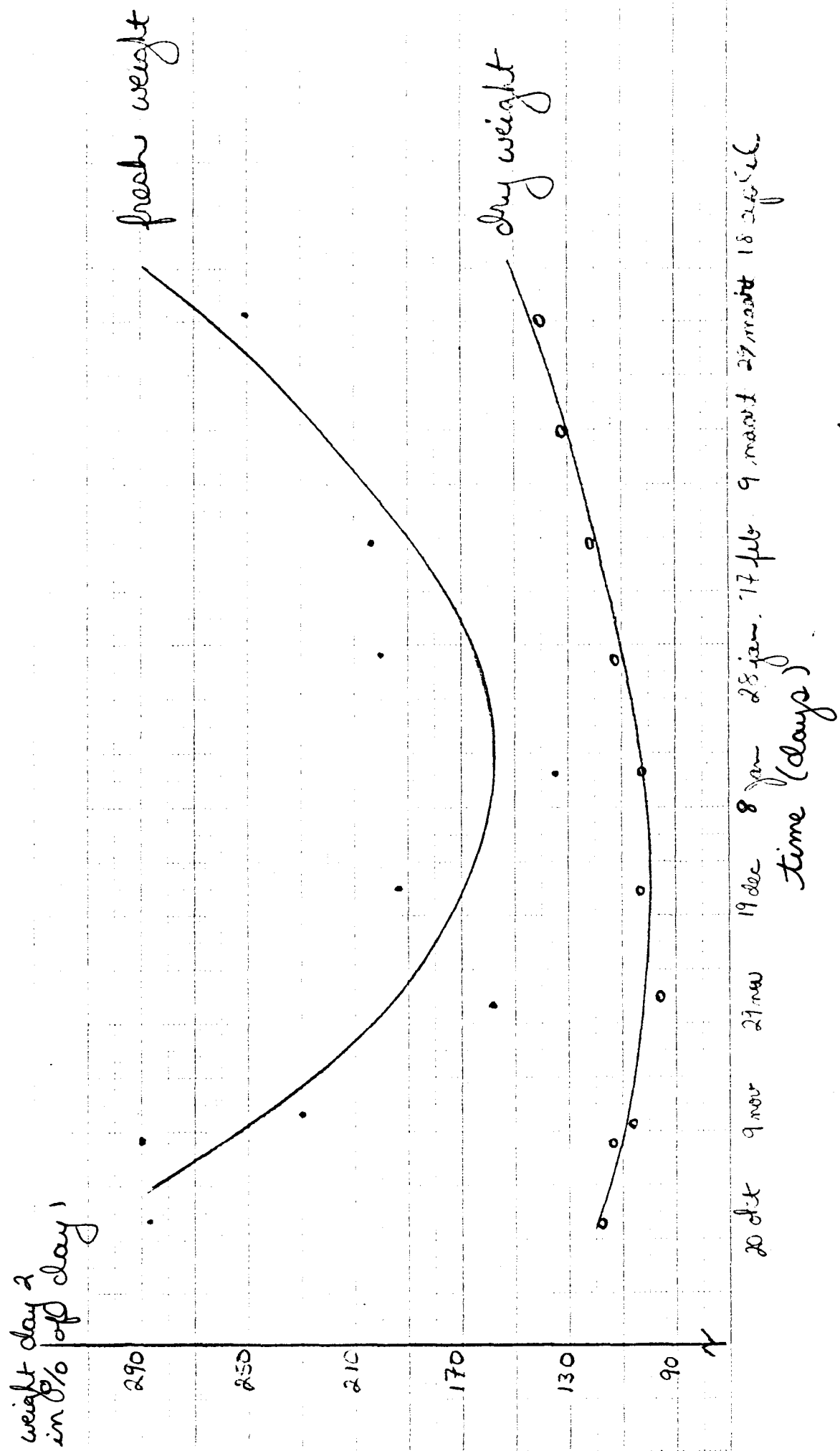


Figure 1. Fresh and dry weight of tomato seedlings the second day of growth in percent of the first day.

3.2 Cucumber

3.2.1 Results for the different experiments

The fresh and dry weight, % dry weight and leaf area for each experiment are given in appendix 2. The dry weight decreases slightly during the first day in 4 of the 5 experiments, after which it increases with each sample. The fresh weight and leaf area on the other hand increase with each sample starting from the first day. The % dry weight for the first sample is relatively high (15.7-35), but decreases rapidly after the first day. By the fourth day the % dry weight is relatively constant (6.5-6.9). The % dry weight was also 6.8 after 14 days for experiment no. 2.

The sample weight and leaf area in % relative to the weight and leaf area of the day before are given in table 2. In general there is little or no increase in dry weight between the first and second day. After the second day the dry weight increment increases up to the fifth day for experiment 1 and 2 and the fourth day for experiment 3. The fresh weight and leaf area increase greatly between the first and second day. After the second day the fresh weight and leaf area increments tend to decrease and continue to decrease up to the fifth day.

Table 2. The sample fresh and dry weight and leaf area in % of the day before.

Experiment	Day no. after emergence			
	1-2	2-3	3-4	4-5
1				
fresh weight	172	181		140
dry weight	92	120		156
leaf area	--	213		145
2				
fresh weight	192	189	162	160
dry weight	100	109	147	151
leaf area	--	255	143	190
3				
fresh weight	241	164	160	130
dry weight	104	123	165	125
leaf area	--	187	161	123
4				
fresh weight	129	211		
dry weight	106	105		
leaf area	332	322		
5				
fresh weight	190			
dry weight	114			
leaf area	318			

3.2.2 The difference in fresh and dry weight immediately following emergence

In Figure 2. the fresh and dry weight from experiment no. 2 are presented on a logarithmic scale plotted against time. The fresh and dry weight both increase linearly starting with day 1. The slopes of the curves determined for the period day 1-3, are shown in the figure.

The slope of the fresh weight curve is clearly greater than the dry weight

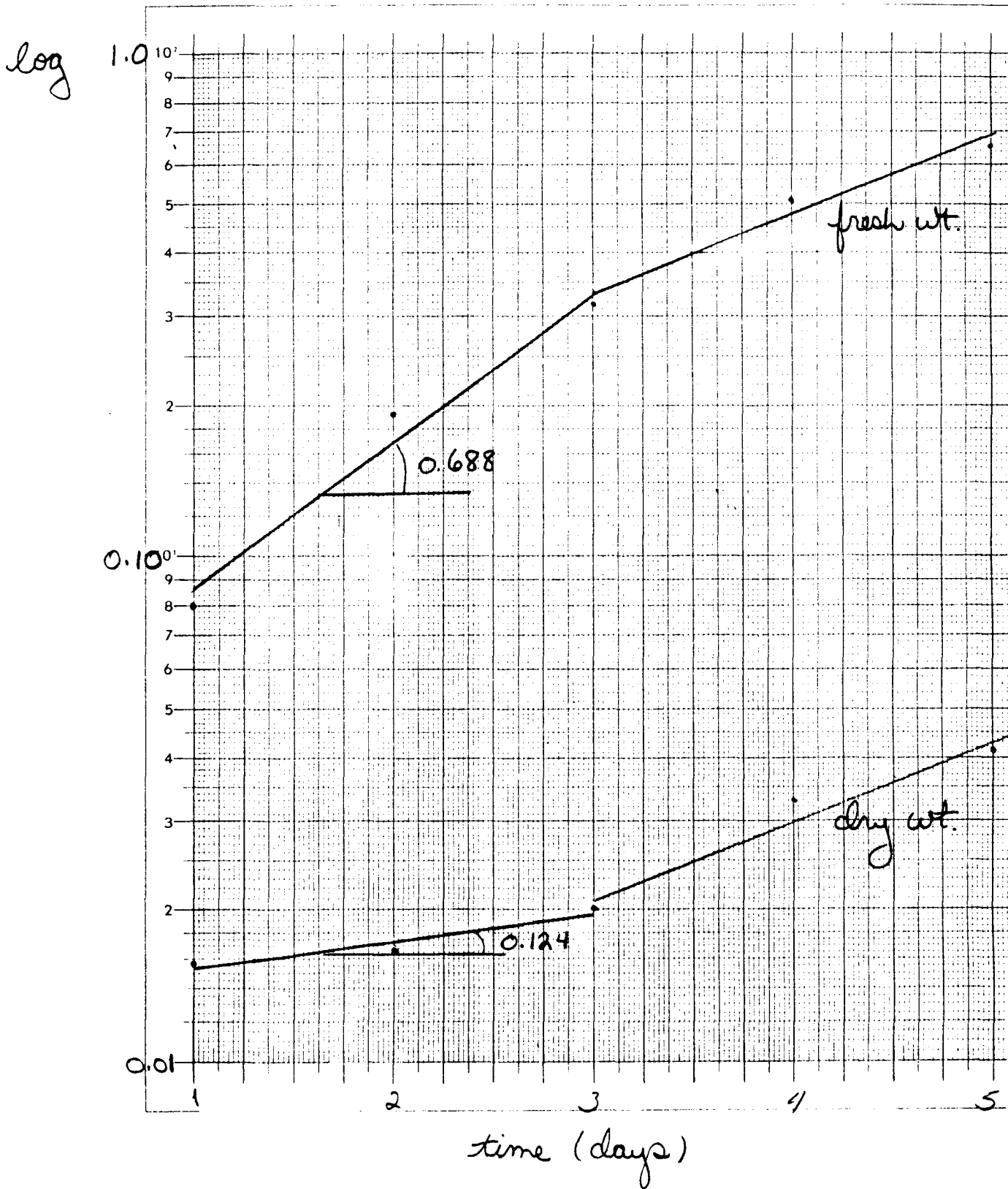


Figure 2. The average curve slopes for fresh and dry weight of cucumber seedlings the first three days after emergence.

curve. Therefore the dry weight is increasing at a slower rate than fresh weight directly following emergence. In Figure 3. these curves are extended to the time the plants reach a fresh weight of 10g fresh weight (day 15). After day 3 the slope of the curves change. The fresh weight curve slope decreases by 57 % after day 3. The dry weight curves slope increase by 147 %. Further more the dry and fresh weight curve slopes are approximately the same after day 3.

3.2.3 Leaf area and weight increases.

Unfortunately there was no complete set of data collected on leaf area from emergence to 10 g fresh weight. The leaf area measurements were usually made after day 1 because of the difficulty of measurement for the small leaf size. The curve slope for leaf area from experiment no. 2 is similar to fresh weight in the first part of the curve when the curve slope is determined for days 2-4, and similar to both fresh and dry weight in the second part of the curve for days 4-16 (Fig. 4).

3.2.4 RGR values for the period from emergence to 10g fresh weight.

In most of our experiments concerning the effect of light and season on the growth of young plants the RGR values for fresh and dry weight and leaf area are determined for the period from emergence to 10g fresh weight.

In Figure 5 the logarithmic curves are presented for experiment no. 2 from emergence to 10 g fresh wt. The slope of the leaf area curve is determined from day 2. In this experiment the plants weighed 10g by day 15. The curve slopes or RGR value for fresh weight is approximately 10 % higher than dry weight. The leaf area RGR determined without day 1 is the same as the dry weight. In Figure 6 the same data are presented again. The curves are determined without day 1. The RGR values for all three curves are approximately the same. The dry weight RGR remains unchanged from that in Fig. 5 and the fresh weight (and probably leaf area) decreases.

4. Discussion

The growth patterns for cucumber and tomato were similar immediately following emergence. The fresh weight (water uptake) increased greatly the first 24 hours after emergence. The dry weight showed little or no increase during this period and in some cases actually decreased. Apparently there is little dry matter assimilation occurring during this period and dry weight can decrease due to respiration. Similar effects were seen in the work of Klapwijk and v. Beek (1972) with tomato. In their work the fresh weight was 200 % greater 24 hours after emergence in the fall and spring. This effect was influenced by seasonal radiation patterns, the increases being much less in the winter (40 %). The dry weight showed a similar effect, but to a lesser extent, the % increase being 40 in the fall and spring and little or no increase in the winter. The % dry weight was high during the first 24 hours, but decreased rapidly by the second day.

The % dry weight was also high in this experiment during the first day, but decreased rapidly by the second day because of the tremendous increase in fresh as compared to dry weight. After 4 to 5 days the % dry weight appeared to be constant and remained constant for a period of 2 weeks with cucumber. The difference in fresh and dry weight increase can be clearly seen in Figures 2-4. During the first few days after emergence the slope of the fresh weight curve is approximately 6 times greater than dry weight. After day 3 the

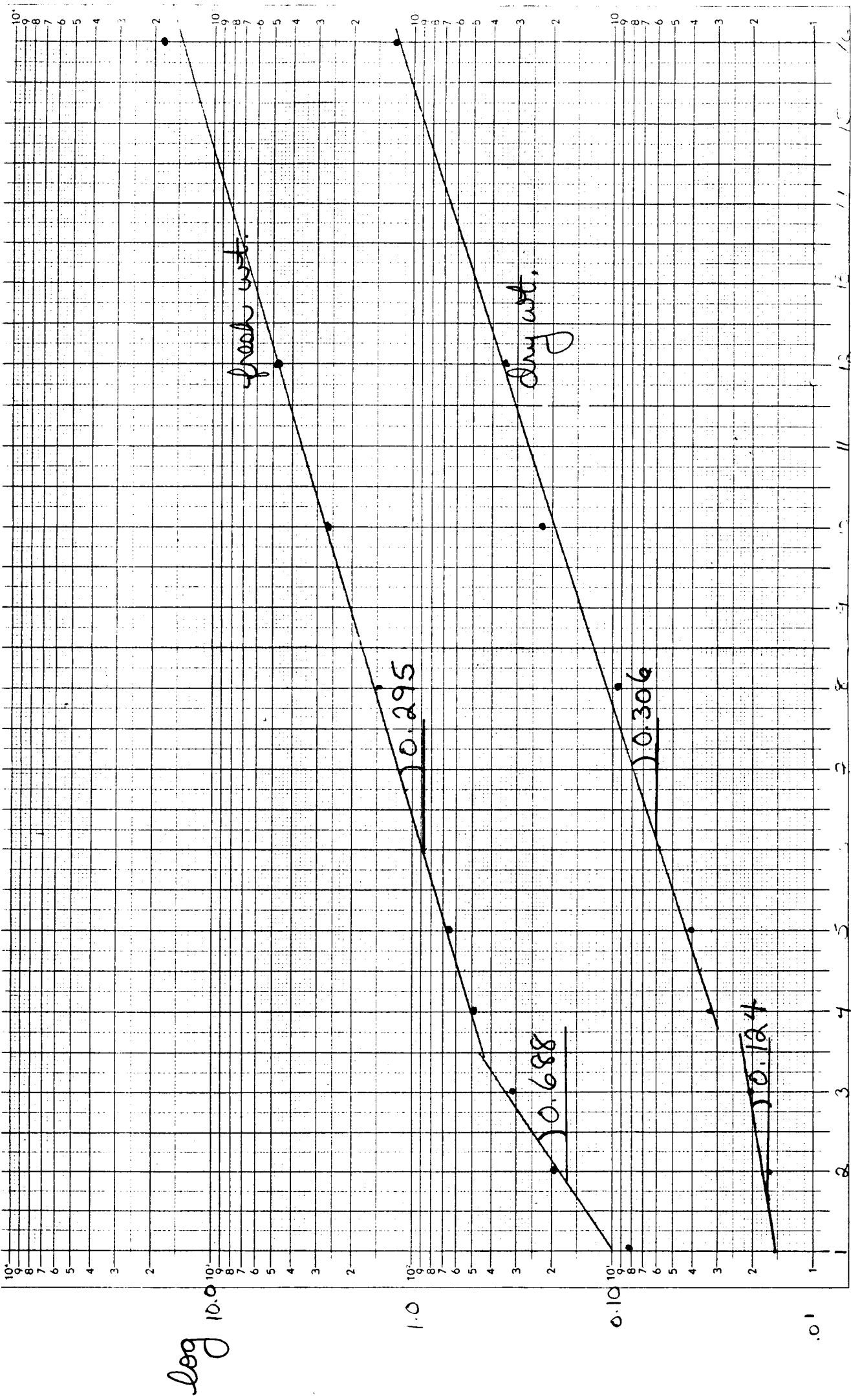


Figure 3. The average curve slopes for fresh and dry weight of cucumber seedlings for days 1-3 and 4-16. time (days)

200

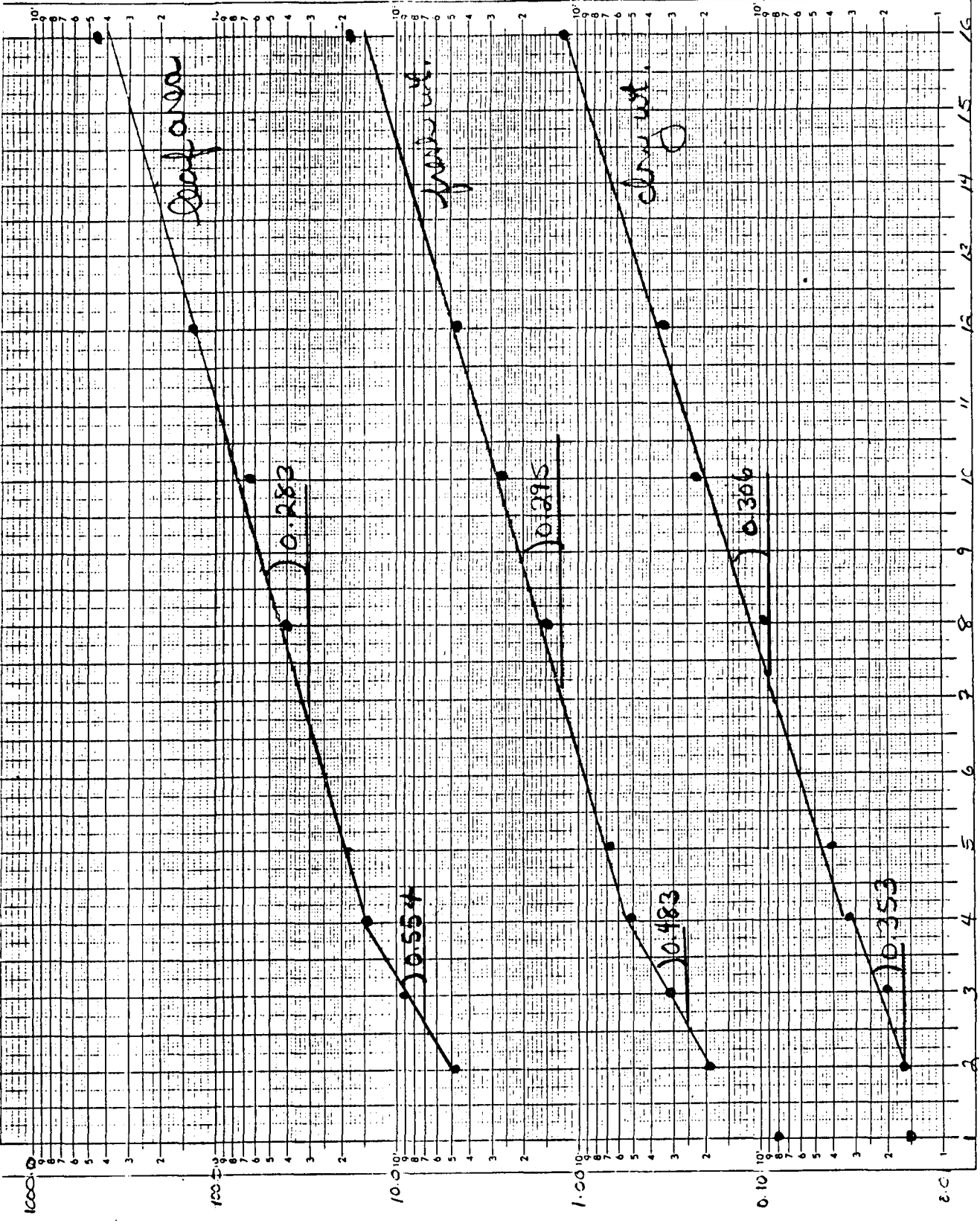
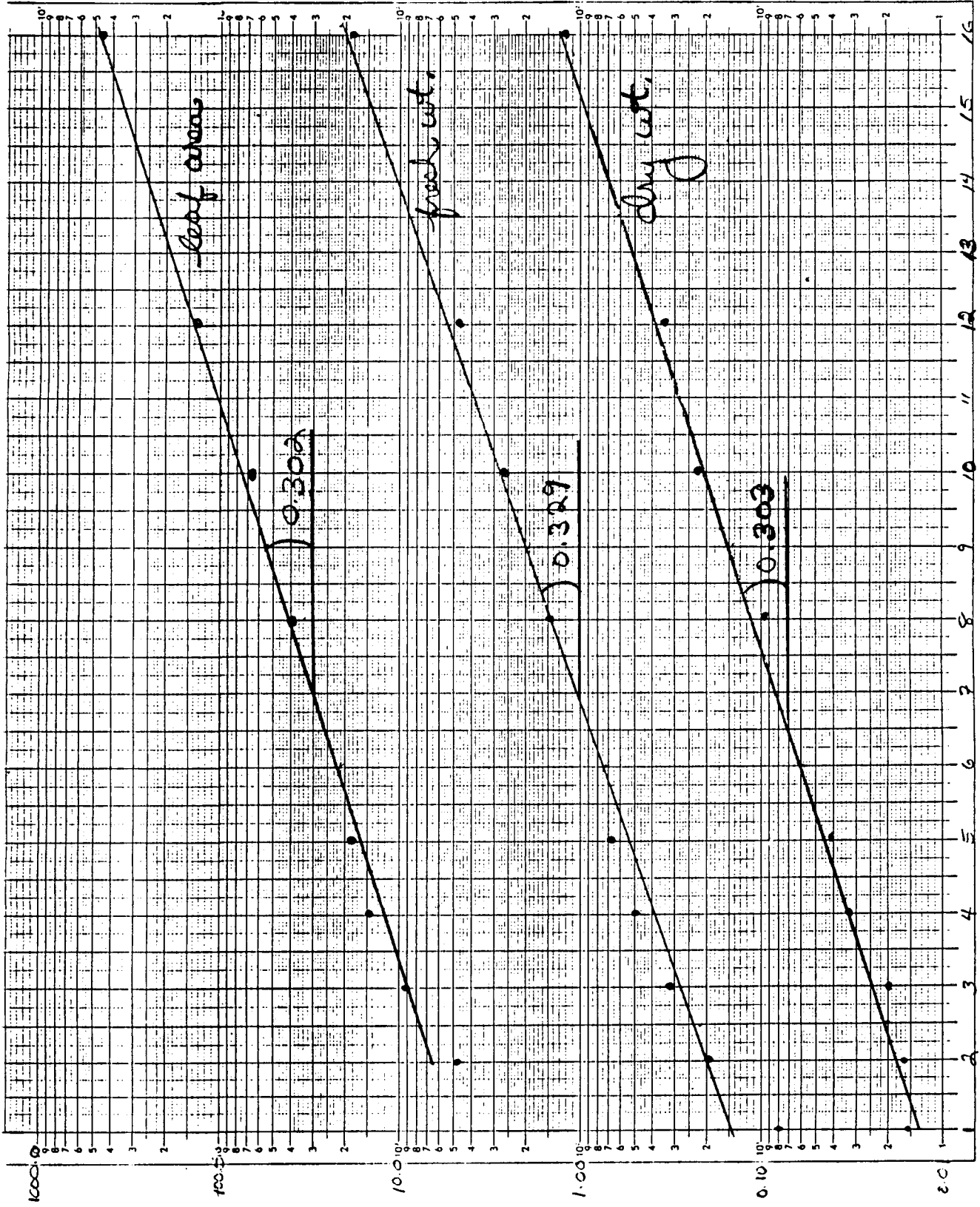


Figure 4. The average curve slopes for fresh and dry weight and leaf area of cucumber seedlings determined for days 2-3 and days 4-16.

leaf



time (days)

Figure 5. The average curve slopes for fresh and dry weight and leaf area of cucumber seedlings determined for the period, days 1-16

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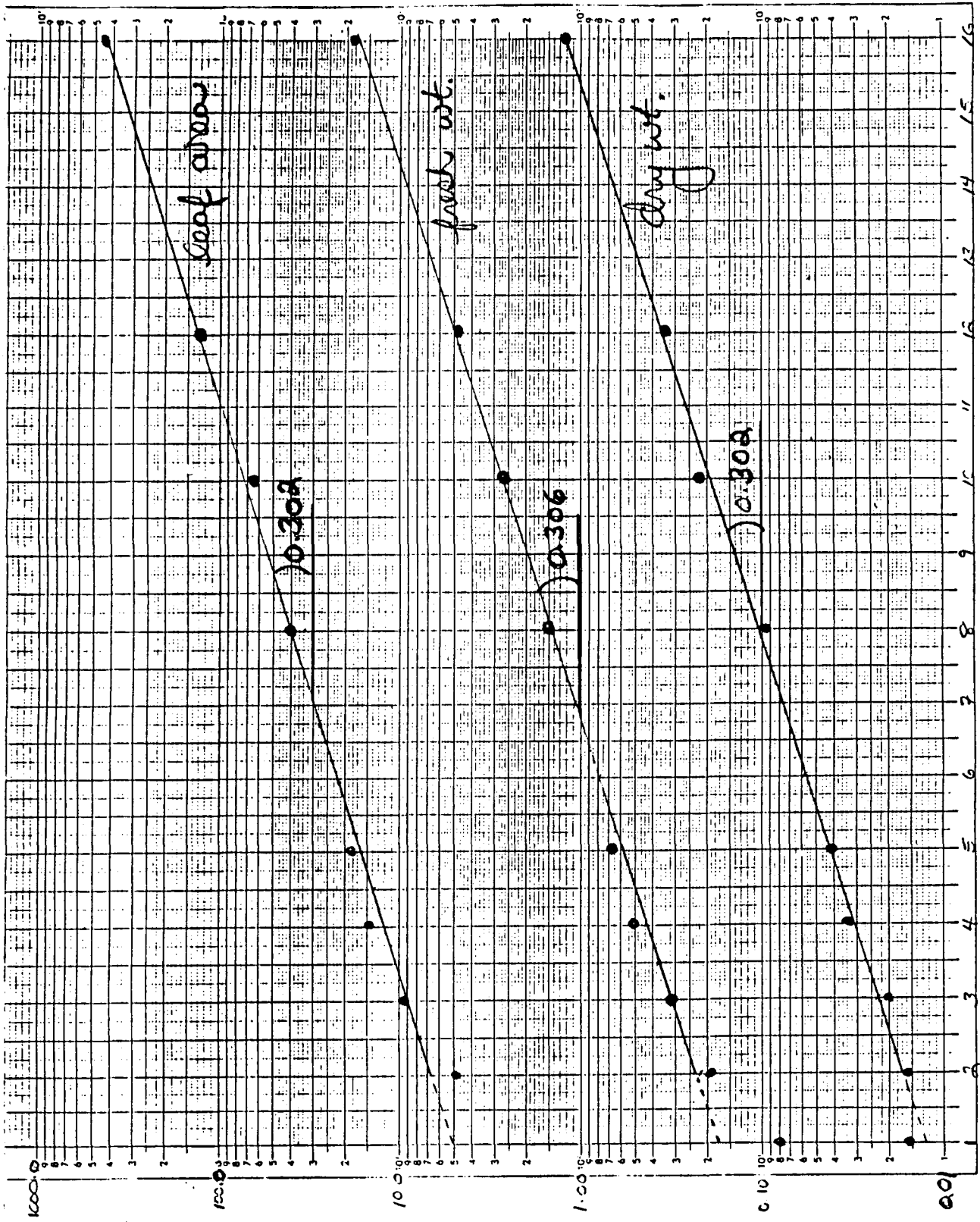


Figure 6. The average curve slopes for fresh and dry weight and leaf area of cucumber seedlings determined for the period Jan 2-16. time(days)

curves for fresh and dry weight are similar. The leaf area curves are similar to fresh weight immediately following emergence, and slightly less than the weight curve slopes after day 3. The average % increase per day was 36 for fresh and dry weight and 33 for leaf area. When the average RGR value is determined for the period from days 1-15 the RGR values for fresh weight is approximately 10 % higher than dry (Table 3). When the RGR values are determined for the period from days 2-15 the average RGR for fresh and dry weight and leaf area become similar. The dry weight curve RGR values are effected little by changes in the calculating period for days 1-15 (Table 3). Whereas the fresh weight and leaf area RGR values can vary as much as 10%.

Table 3. Average RGR values determined for different growth periods for cucumber (experiment no. 2) for the period from emergence to day of 10 g fresh weight.

15-29 July period (days)	Average RGR				
	1-15	2-15	3-15	4-15	5-15
fresh wt. (g/g/day)	0.331+	0.308	0.300	0.295	0.302
dry wt. (g/g/day)	0.301+	0.306	0.303	0.306	0.310
leaf area (cm ² /cm ² /day)	--	0.302+	0.288	0.283	0.292

5. Conclusions

It could be said that during the first few days after emergence the seedlings are still in the germinating phase. This period lasts from emergence to the time the dry matter dilution is constant (day 4). The greatest change in fresh weight and % dry weight occurs however, during the first 24 hours of growth. Consequently the RGR values for the first few days of growth can vary considerably from later RGR values. This effect can also be seen in average RGR values determined for a longer growth period. The average RGR for fresh weight for the period from emergence to 10g fresh weight was 10% higher when the first day measurements were included. For the dry weight the RGR values showed little or no change when determined with and without day 1. There is a good agreement between RGR values for fresh and dry weight and leaf area when the values are determined starting with the second day of growth.

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Appendix 1. Fresh and dry weight and leaf area for tomato seedlings
'Abunda' 1 to 5 days after emergence.

Experiment 1. (15-19 July)

days	1		2		3		4		5	
sampling time*	a	b	a	b	a	b	a	b	a	a
fresh wt.(mg)	9.97	7.0	11.3	17.3	23.3	24.3	39.3	51	50.7	
dry wt.(mg)	1.55	1.24	1.31	1.66	1.53	2.46	3.02	3.93	3.68	
% dry wt.	15.5	17.7	11.6	9.6	6.57	10.1	7.68	7.7	7.26	
leaf area(cm ²)	--	--	0.187	0.303	0.573	0.733	1.09	--	1.62	

Experiment 2. (24-26 July)

days	1		2		3	
sampling time	a	b	a	b	a	a
fresh wt.(mg)	10.7	14.7	19.3	24.3	36.0	
dry wt.(mg)	1.32	1.68	1.75	2.78	2.70	
% dry wt.	12.3	11.4	9.1	11.4	7.5	
leaf area(cm ²)	--	--	0.459	0.662	1.08	

Experiment 1. (1-2 Aug.)

days	1			2		
sampling time	a	c	b	a	c	b
fresh wt.(mg)	9.33	10.0	10.3	14.7	16.0	17.0
dry wt.(mg)	1.36	1.30	1.50	1.52	1.54	1.80
% dry wt.	14.6	13.0	14.6	10.3	9.62	10.6
leaf area(cm ²)	0.167	0.196	0.215	0.39	0.352	0.530

Experiment 4. (27-28 Aug.)

days	1			2		
sampling time	a	c	b	a	c	b
fresh wt.(mg)	13.1	7.93	10.3	15.7	16.6	16.0
dry wt.(mg)	1.47	1.28	1.44	1.55	1.65	1.68
% dry wt.	11.2	16.1	14.0	9.9	9.9	10.5
leaf area(cm ²)	0.0745	0.102	0.127	0.26	0.281	0.347

* a= sampling time at 8.30
 b= sampling time at 16.30
 c= sampling time at 12.30

Appendix 2. Fresh and dry weight and leaf area for cucumber seedlings
'Uniflora D' 1 to 6 days after emergence.

Experiment 1. (9-14 May)

days	1		2		3		4		6	
sampling time*	a	b	a	b	a	b	a	b	a	b
fresh wt.(g)	0.072		0.124		0.224		0.508		0.713	
dry wt.(g)	0.0176		0.0163		0.195		0.0350		0.0547	
% dry wt.	24.0		13.1		8.7		6.9		7.7	
leaf area(cm2)	--		2.97		6.34		14.4		21.0	

Experiment 2. (15-19 July)

days	1		2		3		4		5	
sampling time	a	b	a	b	a	b	a	b	a	b
fresh wt.(g)	0.08	0.106	0.193	0.240	0.317	0.343	0.507	0.577	0.657	
dry wt.(g)	0.0156	0.0149	0.0163	0.0188	0.20	0.030	0.033	0.040	0.0413	
% dry wt.	19.5	14.0	8.4	7.8	6.0	8.7	6.5	6.9	6.3	
leaf area(cm2)	--	--	4.92	6.20	9.22	10.0	14.9	16.1	18.4	

Experiment 3. (22-26 July)

days	1		2		3		4		5	
sampling time	a	b	a	b	a	b	a	b	a	b
fresh wt.(g)	0.0726	0.080	0.140	0.201	0.265	0.332	0.430	0.501	0.686	
dry wt.(g)	0.0173	0.0172	0.0173	0.0204	0.0188	0.027	0.0276	0.0433	0.0418	
% dry wt.	24	21.5	12.3	10.0	7.1	8.1	6.4	8.6	6.1	
leaf area(cm2)	--	--	3.16	5.29	8.08	9.67	11.6	15.4	22.1	

Experiment 4. (31 July- 2 Aug.)

days	1			2			3		
sampling time	a	c	b	a	c	b	a	c	b
fresh wt.(g)	0.0497	0.0578	0.0640	0.104	0.1177	0.141	0.220		
dry wt.(g)	0.01723	0.176	0.1829	0.184	0.184	0.1858	0.1933		
% dry wt.	35	30	28	18	15.6	13	8.8		
leaf area(cm2)	0.473	0.474	0.718	1.57	2.11	2.87	5.07		

Experiment 5. (27-28 August)

days	1			2		
sampling time	a	c	b	a	c	b
fresh wt.(g)	0.102	0.0937	0.121	0.163	0.178	0.174
dry wt.(g)	0.016	0.149	0.0169	--	0.017	0.0177
% dry wt.	15.7	15.9	14	--	9.6	10.2
leaf area(cm2)	0.84	1.27	2.17	3.7	4.04	3.88

* a= sampling time at 8.30
 b= sampling time at 16.30
 c= sampling time at 12.30