THE EFFECT OF SUMMER PRUNING TREATMENTS ON GROWTH AND FRUITFULNESS IN THE RED RASPBERRY

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References

THE EFFECT OF SUMMER PRUNING TREATMENTS ON GROWTH AND FRUITFULNESS IN THE RED RASPBERRY

by

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INTRODUCTION.

Many early writers on red raspberry growing mention the practice of summer pruning; some commend it and others disapprove of it. Perhaps this is not to be wondered at since little or no experimental evidence dealing with the problem has been published.

Baker (1) in 1866 wrote the following summary of the method recommended in summer pruning, then in common use:

" Summer pruning consists in cutting out the old canes after they have fruited, and the superfluous weak shoots. This strengthens the buds upon the new canes. By a judicious winter pruning the season can be extended through six weeks."

Probably the statement regarding the renoval of old canes cannot be classed as a method of summer pruning. However the mention of superfluous and weak shoots can certainly be thus applied.

Beadle (3) in speaking of pruning at the time of old cane renoval says,-

" - and of those young canes that have come up, if any of them should be weak and slender, it is always advisable to cut them away at this time leaving only those that are vigorous and capable of supporting a crop of fruit."

In defending the practice of summer pruning Fuller(5) says:- " - because no other pruning is generally practiced

it is "no sufficient reason why it is not necessary, or that it would not be beneficial."

Card (4), Lewis (7), Riehl (8), Roe (10), and Taylor (12) affirm that no benefits can be found with summer pruning and therefore do not advocate it.

Thornber (13) recommends the thinning and selection of next year's canes throughout the summer. Thomas (11) claims that suckering sorts to bear well must have the suckers hoed away when they first appear above the ground.

Patrick Barry (2) understands that summer pruning is the pinching of the new shoots when they are from 2½ - 3 feet high and later pinching the resulting shoots or laterals when they attain a length of one foot.

It will be seen from the foregoing that summer pruning has been a much discussed question. However, discussion and recommendations apparently have been based on observation alone or on theoretical considerations for in no instance are the results of carefully conducted trials given.

MATERIALS AND METHODS.

A Cuthbert red raspberry plantation on the grounds of the Horticultural Experiment Station, Vineland Station, Ontario, Canada, was used for the field trials employed in this experiment. The portion of the field that was used consisted of seven rows, sixty feet long and eight feet apart, running North and South, in which the plants were trained to the hedgerow system.

The soil was of an apparently uniform sandy loam, well underdrained. Previous to this experiment the plot had received the usual cultural and pruning treatments consisting of: 1. Pruning out of the old wood in August, after the crop had been removed. 2. Dormant pruning in early April consisting of the thinning out of the canes to the required number and tipping the whole plot at approximately four feet in height. 3. Consistent and regular summer cultivation up to picking time, with a light discing of the runways after each picking to break up the packed crust. 4. Manuring and plowing in the fall. The plot as a whole was of uniform growth and fruitfulness and was six years old at the start of the experiment.

In the spring of 1924 the plot was pruned in the usual way. Weak shoots and all surplus canes were removed. All the laterals were cut back half their length and the

whole plantation tipped at four feet.

PLAN OF THE EXPERIMENT.

The patch was divided into seven plots, numbering from West to East with Plot 6 serving as Check. The various treatments employed were as follows:

PLOT 1.
The new shoots coming up after the crop had been removed were cut out.

PLOT 2.
No new shoots were thinned from this plot during the season of 1924. In 1925 the old canes were allowed to develop and fruit normally but a certain number of new shoots, enough for next year's fruiting canes, were pinched when about 24 inches high. The remaining new shoots were then removed.

PLOT 3.
For a period of eight weeks at the beginning of the growing season all the shoots coming up were removed. After that time all new shoots were allowed to grow.

If the supposition that the early canes really are competitive with the fruiting canes largely for moisture supply, but also for plant nutrients to a lesser extent, this treatment should show marked benefit over those plots which were not so treated.

PLOT 4.

All the new shoot growth, other than those new shoots that were retained for next year's fruiting canes, were removed for an eight week period.

This plot was in effect the reverse of the preceding plot in that it uses the early canes that come up for the following season's fruiting wood, while Plot 3 utilizes the late canes.

PLOT 5.

The plants were handled in the normal way until the blossoming season was over and the first berries were getting to be of good size but still showing no signs of ripening. Then all the shoots were removed except the comparatively small number which were left to serve as fruiting canes for the following year.

This plot was included to throw light on the question of competition between the individual new shoots, those destined to become fruiting canes for the following year, during the latter part of the season.

PLOT 6.

Check. This plot was given the regular commercial treatment. No summer pruning of any kind was done.

PLOT 7.

Similar to plot 2. After the shoots required for the following year had been pinched, all the remaining shoots were left growing.

In Plot 2 certain shoots were summer pinched and the remainder of the new shoots were cut out. Plot 7 therefore would indicate the effect of pinching accompanied by no removal of the remaining shoots.

PROCEDURE.

In the spring of 1924 each cane remaining after the dormant season pruning was tagged and numbered. Individual cane records were kept of all canes in the experiment.

The records taken at picking time were as follows:

1. Date of picking.
2. Number of berries per cane by pickings.
3. Weight of berries, in grams, per cane by pickings.

In 1925 each cane was labelled as in 1924 and the following measurements were made.

1. Diameter of cane in millimeters.
2. Length of cane in inches.
3. Number of laterals per cane.
4. Length of laterals per cane in inches.
5. Date of picking.
6. Number of berries per cane by pickings.
7. Weight of berries per cane by pickings.

SAMPLING FOR CHEMICAL ANALYSIS.

On November 1st 1924, and 1925, samples were taken for chemical analysis. Three representative canes were chosen from each plot, weighed immediately, cut into thirds according to length, and dried for 72 hours at a temperature of 90° C. In 1925 it was necessary to take five canes from Plot 1 in order to obtain a sufficient amount of dried material for analysis.

METHODS OF ANALYSIS.

Three-gram samples of oven dried material were placed on filter paper and washed ten times with cold distilled water. The washings filtering into 250 cc. Volumetric flasks. The filtrate was cleared with dry Lead Subacetate; made up to volume and filtered. 200 cc. of this filtrate was transfered to a 250 cc. Volumetric flask and de-leaded with dry Sodium Carbonate; made up to volume and filtered.

Free Reducing Sugars. - were obtained by taking a 50 cc. aliquot of the above filtrate and boiling for 2 min. with Fehlings solution made up as follows: 30 cc. Fehlings a, 30 cc. Fehlings B, and 60 cc. distilled water. The boiled solution was then filtered through an asbestos mat in a dried and weighed Gooch crucible; then dried in the oven and weighed as Cuprous Oxide.

Total Sugars. - 50 cc. of the filtrate obtained after de-leading was transfered to a 100 cc. Volumetric flask and hydrolized with 5 cc. conc. HCl for fifteen minutes in a water bath at 70° C. It was cooled, neutralized with NaOH and made up to volume. 50 cc. of this solution was used for a determination.

Starches. The residues from the first washings were washed into 250 cc. beakers and gelatinized by heating. After cooling .03 gram Taka Diastase in 3 cc. distilled water was added to each sample and allowed to incubate for 24 hours. This solution was then washed into 500 cc. Pyrex Erlenmeyer flasks, 8 cc. conc. HCl added, and hydrolysed for two and one half hours. After cooling it was neutralized with NaOH and washed into 250 cc. Volumetric flasks. The solution was then treated as for Free Reducing Sugars.

Total Polysaccharides. Three grams of the original dried sample were placed on filter paper and washed with 200 cc. distilled water to remove all free reducing substances. The residue was washed into 500 cc. Pyrex Erlenmeyer flasks and treated as for starch where it was washed into a similar flask. The dextrose reading was converted to polysaccharides by the factor 0.90.

All the weights were calculated on an oven dry basis. Weights of Cuprous Oxide were converted to dextrose by means of Allihn's Tables.

EXPERIMENTAL DATA

WEATHER DATA

Records of temperature, sunshine, and precipitation were taken for the two fruiting seasons, 1924 and 1925. These are presented in tables 1 and 2.

Table 1.-Weather data for the summer of 1924

Date	TEMPERATURE MAX. °F.	MIN. °F.	Hourly Mean °F.	Hours of Sunshine	Precipitation (Inches)
July					
16	81	67	70.2	5.0	
17	67	54	61.4	11.5	0.60
18	77	53	61.6	10.6	
19	69	53	62.7	13.0	
20	74	58	63.6	12.2	
21	75	60	65.4	12.8	
22	81	79	74.7	6.5	
23	85	68	76.3	12.9	
# 24	87	73	76.1	3.6	
25	79	61	66.3	9.8	0.56
26	73	57	63.5	8.9	
27	78	63	70.2	12.9	
# 28	84	71	77.0	6.9	
29	88	69	76.3	9.7	
30	80	70	72.6	3.1	0.22
31	72	61	62.2	4.2	1.23
August					
1	66	55	59.7	11.7	
2	65	53	59.7	12.8	
3	68	65	62.4	9.8	
# 4	79	70	74.3	2.2	0.62
5	76	64	70.3	10.0	0.21
6	84	76	75.3	6.1	0.30
7	83	69	71.6	10.7	0.67
8	80	64	72.1	6.6	
9	76	68	69.2	10.3	
# 10	73	62	66.6	8.9	0.75
11	75	56	64.0	10.4	
12	74	60	65.5	11.6	
13	72	59	61.3	1.8	0.51
# 14	64	55	61.2	12.3	
15	73	57	65.9	11.8	
Averages	76.0	62.9	67.7	9.0	Total 5.67

= Picking Dates.

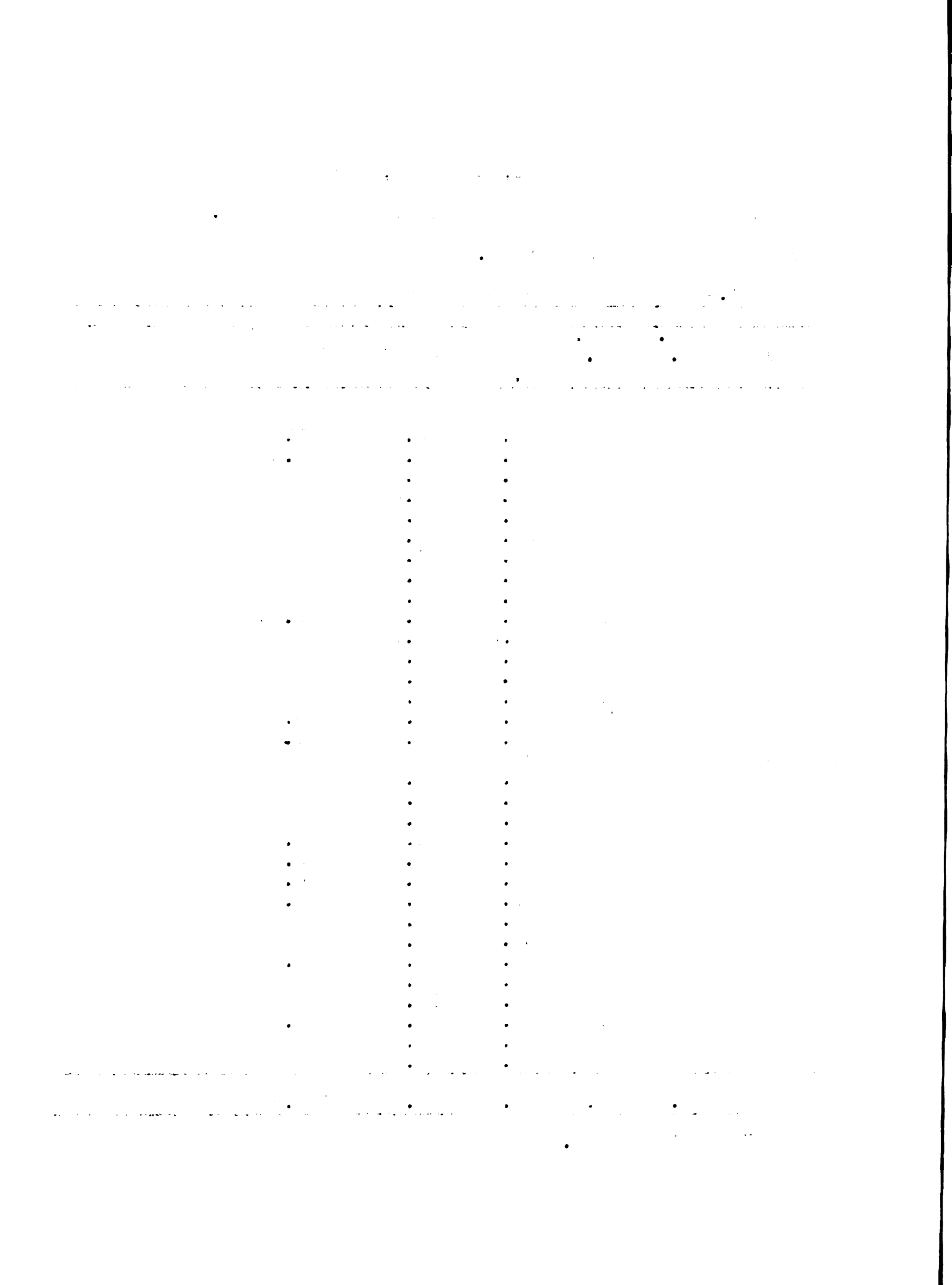

Table 2.-Weather data for the summer of 1925

Date	TEMPERATURE Max. °F.	Min. °F.	Hourly Mean °F.	Hours of Sunshine	Precipitation (Inches)
July					
16	86	73	70.9	5.8	0.32
17	74	55	59.4	3.3	
18	80	54	65.6	10.0	
19	84	52	68.5	12.3	
20	84	62	72.2	2.5	
# 21	82	70	71.2	2.4	0.08
22	80	63	64.1	9.0	2.05
23	76	60	65.1	11.4	
24	84	54	66.2	9.7	
25	80	64	65.7	3.1	
26	72	62	64.4	4.6	
27	77	60	65.5	7.7	0.08
28	67	60	61.9	3.5	0.81
# 29	70	49	59.2	8.9	0.05
30	75	50	61.0	11.8	
31	74	55	60.6	.6	
August					
1	66	56	60.2	2.1	2.78
2	80	58	64.4	9.9	
# 3	82	58	66.9	11.3	0.38
4	82	58	65.9	11.9	
5	74	62	66.2	3.6	
6	76	63	66.9	4.3	0.19
7	75	60	66.0	6.4	
8	78	66	68	.1	0.03
9	78	68	68.2	4.5	0.10
# 10	84	68	71.3	9.1	
11	80	61	67.2	12.5	
12	76	56	64.6	2.4	
13	73	64	66.5	2.0	0.21
14	74	66	65.8	5.2	0.21
15	80	60	67.7	12.1	
Average	77.5	60.2	65.7	6.5 Total	7.29

Picking Dates.

The tables show that during the period of July 16th to August 15th, inclusive, the daily mean temperature was fairly high in both 1924 and 1925.

In 1924 we had a daily mean of 67.7° F with an average of 9.0 hours of sunshine per day. In 1925 the daily mean was 65.7° and the average daily sunshine 6.5 hours. During the same period there was a total rainfall of 7.29 inches in 1925, as compared with a total of 5.67 inches in 1924. In no instance was there any apparent response in all plots to the heavy rains between pickings in 1925, either in yields of fruit or in the size of the berry. This indicates that probably at no time either year was moisture supply during the fruiting season a limiting factor to production.

FRUIT RECORDS.

While it was assumed that all the plots at the start of the experiment were fairly uniform as judged by outward appearances, it is quite apparent from tables 3 and 4 that such was not the case. That they were not entirely uniform is indicated by the fact that, though plots 1 and 6 received identical treatment until after the fruiting season of 1924, the difference in their average yields per cane was almost as great that year as between any two plots receiving different treatments early in the season. While this might be due to small unnoted differences in the cane diameters

Table 3.- Number and weight of fruit by pickings, in grams--1924

PLOT	July 24		July 28		August 4		August 10		August 14	
	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight
1	249	463	1314	1831	2576	3880	1537	2201	567	569
2	432	692	1233	1641	2903	3880	1254	1549	436	443
3	399	694	2144	2770	3513	4672	1767	2253	524	574
4	149	250	844	1069	2096	3055	1175	1661	453	581
5	336	584	1664	2684	1490	2057	1189	1659	370	437
6	529	833	1911	2813	1690	2276	977	1162	321	329
7	238	382	851	1129	1834	2482	1010	1327	401	480

Table 4.- Fruiting Summary for 1924

PLOT	Total number of berries	Total weight of berries	Number of canes	Av.weight of fruit per cane	Av.No.of berries per cane	Av.weight of berry
1	6143	8944	50	198.8	122.8	1.45
2	6258	8205	63	130.2	99.3	1.31
3	8347	10963	66	166.1	126.4	1.31
4	4717	6616	44	150.3	107.2	1.40
5	5049	7421	54	137.4	93.5	1.46
6	5428	7413	48	154.4	113.0	1.36
7	4334	5800	47	123.4	92.2	1.33

this same statement may be made regarding the figures for the size of berry in 1924. This makes it impossible to accept the figures for any two plots which differed in their early summer treatment and therefore no interpretations of this sort are attempted. It is significant, however, that where the average fruiting records for those plots in which the early summer shoot growth was removed entirely or thinned out are considered together and compared with the records for those plots in which the early summer shoots were left undisturbed, there appears to be no advantage in favor of such an early reduction of shoots. In other words there is no evidence of their being parasitic on or detrimental to the growth and fruit production of the fruiting canes. Indeed, if anything, they seem to help; and on this point the evidence is clear.

Tables 5 and 6 present data on fruit production for the 1925 season. More canes were used per plot in 1924 than in 1925 because it was found that the larger number of canes required more than one day to pick the fruit. Therefore it was deemed advisable to reduce the number of canes so that the fruit could all be gathered the same day.

If the records of 1924 are difficult of interpretation those of 1925 are even more so, for, in addition to any possible plant variation, there is still the possible residual effect of the treatments applied the previous season as registered through their effect on the new shoot growth

Table 5.- Number and weight of fruit by pickings, in grams--1925

PLOT	July 13		July 21		July 29		August 3		August 10	
	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight
1			465	647	1420	1700	1021	1184	364	511
2			279	370	1462	1935	1498	1748	953	1038
3	273	369	409	618	1317	1847	1065	1481	602	841
4			520	748	1300	1646	1046	1271	638	726
5			330	487	888	1218	1001	1178	432	467
6			673	882	2100	2667	2169	2503	1016	1178
7			222	277	1326	1380	1365	1474	720	743

Table 6.-Fruiting Summary for 1925

PLOT	Total number of berries	Total weight of berries	Number of canes	Av.weight of fruit per cane	Av.No.of berries per cane	Av.weight of berry
1	3270	4042	24	168.4	136.2	1.23
2	4192	5091	32	159.0	131.0	1.21
3	3666	5156	35	147.3	104.7	1.10
4	3504	4391	31	141.6	113.0	1.25
5	2651	3350	27	124.0	98.1	1.26
6	5958	7230	67	107.9	88.9	1.21
7	3633	3874	39	99.3	93.1	1.06

of that season. Generally 1925 was a less favorable season than 1924 from the standpoint both of yield and size of berry. All plots except #2 showed decreases. However, since the check plot showed the greatest decrease, it might be taken that all the pruning treatments of the previous season had some beneficial effects, although the differences are not significant.

It is quite apparent in table 6 that the early canes are the best to leave for subsequent fruiting, Plot 1 standing ahead of the remainder of the treatments. It would also appear that these new shoots are not competitive with the fruiting canes - rather they are more of a benefit than a detriment. Plot 3 which contained only late formed canes had no influence on bettering the total yield of the plot, while Plot 1 having early canes did give a better yield.

Pinching the young growth accompanied by the removal of the surplus shoots helped to increase the yield per cane, while pinching with no surplus cane removal proved fatal to the plot. This contrast is well brought out by plots 2 & 7. It might also be added that where there was no removal of canes, as in Plot 6, the check plot, the yield was decreased.

Tables 7A and 7B give the fruiting record by pickings for the two seasons with respect to average number of berries per cane and average weight of berry.

Table 7.-Average number of berries per cane and average weight per berry, in grams--1924

PLOT	July 24		July 28		August 4		August 10		August 14	
	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight
1	4.98	1.85	26.28	1.39	50.15	1.50	30.74	1.43	9.34	1.21
2	6.85	1.60	19.57	1.33	46.08	1.33	19.89	1.23	6.98	1.01
3	6.04	1.73	32.48	1.24	53.22	1.32	26.77	1.27	7.93	1.09
4	3.38	1.67	19.18	1.26	47.54	1.45	26.70	1.41	10.29	1.28
5	6.22	1.73	30.81	1.61	27.59	1.38	22.01	1.39	6.85	1.18
6	11.02	1.57	39.81	1.47	35.20	1.34	20.35	1.18	6.68	1.02
7	5.06	1.60	18.10	1.32	39.02	1.35	21.48	1.31	8.53	1.19

Table 7 B.- Average number of berries per cane and average weight of berry, in grams--192

	July 13		July 21		July 29		August 3		August 10	
PLOT	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight
1			19.37	1.39	59.16	1.19	42.54	1.15	15.16	1.40
2			8.71	1.32	45.68	1.32	46.81	1.16	29.78	1.07
3	7.80	1.35	11.68	1.51	37.62	1.40	30.42	1.39	17.20	1.39
4			16.77	1.43	41.93	1.26	33.74	1.20	20.58	1.13
5			12.22	1.47	32.88	1.37	37.07	1.17	16.00	1.08
6			10.41	1.31	31.34	1.27	32.37	1.11	13.67	1.16
7			5.59	1.24	34.00	1.04	35.00	1.08	18.46	1.03

CANE MEASUREMENTS.

The data from measurements made on the diameter and length of the canes in the several plots, together with the mean weight of fruit per cane for 1925, are presented in Table 8. The diameter measurements were taken at the base of the cane by means of a steel caliper.

Table 9 gives the coefficients of correlation calculated by the Pearsonian formula $r \frac{(xy)}{n(\ x\ y)}$.

Diameter of cane cannot be said to give a correlation with the yield of fruit in this investigation, neither average number of berries nor average size of berry giving any positive figures. Length of cane also has no definite bearing on the question other than that plots 2 and 5 gave a very definite negative correlation. This, however, was to be expected, as both these plots received pinching treatments. Percentage of canes with laterals likewise showed no definite relation although plot 1 showed a substantial increase in the percentage of laterals, when compared with the check and those plots which were not summer pinched. The low percentage shown by plot 3 is to be expected as the continued practice of removing the early canes from the patch had an immediate and drastic effect on the vigor of the plants. The column for mean weight of fruit per cane varies slightly with the corresponding column in table 6 because one or more canes in several of

Table 8.-Cane measurements made in spring--1925

PLOT	Mean Diameter (mm)		Mean Length (inches)		Mean weight of fruit per cane (grams)		Percentage of canes with laterals
1	12.60	0.340	60.0	5.50	165	40.3	73.52
2	12.40	0.142	29.0	6.60	158	53.6	87.50
3	8.72	0.973	35.0	5.83	142	51.7	2.85
4	12.10	0.174	55.0	2.83	135	50.4	55.55
5	12.20	0.351	58.0	6.64	121	32.8	77.77
6	11.50	0.154	50.0	5.27	107	47.9	50.70
7	11.40	0.230	37.0	1.28	99	38.2	46.12

Table 9.-Coefficients of correlation between yield in grams per cane and diameter and length of cane

PLOT	1		2		3		4		5		6		7	
R_1	.396	.118	.440	.095	.402	.095	.185	.116	.799	.069	.565	.056	.144	.105
R_2	.566	.095	-.956	.010	.266	.105	.696	.062	.422	.106	.383	.070	-.426	.088

R_1= Diameter of cane with yield. R_2=Length of cane with yield.

the plots were considered unfit subjects for measurement due to mechanical damage.

The defect in the matter of correlation relations is in the fact that cane measurements were not made in 1924 prior to the experiment, nor in the fall of 1925 following the season of 1925. Thus it was not possible to ascertain the amounts of growth with respect to plot treatments. Had this information been obtained, correlations would probably have been more definite, consistent, and valuable.

CHEMICAL ANALYSES.

Table 10 presents data on the chemical analyses of canes taken November 1st 1924. The canes were divided into thirds by measurement. Analysis shows a general increase of Free Reducing Sugars and Total Sugars from the base towards the tip and a decrease of Total Polysaccharides. There seems to be no correlation whatever between the chemical composition of these canes and their fruiting behavior.

Table 10.-Composition of 1925 cane growth--Samples taken in November

Sample	Moisture (%)	Free Reducing sugars (%)	Total sugars (%)	Total polysaccharides (%)
Basal Third				
1	24.1	3.4	7.0	27.1
2	40.0	4.7	8.1	25.7
3	40.5	3.4	6.0	22.8
4	35.6	4.2	6.1	28.7
5	42.6	3.6	7.0	27.8
6	40.9	3.8	6.3	28.8
7	39.0	2.7	5.3	24.8
Middle Third				
1	45.0	3.0	6.5	25.8
2	41.9	5.7	9.0	17.4
3	35.0	3.5	7.7	22.7
4	37.0	3.2	7.2	23.9
5	40.0	4.4	7.4	19.1
6	34.2	4.0	7.7	26.5
7	41.4	4.2	8.1	22.5
Top Third				
1	38.0	4.8	9.9	23.5
2	41.4	5.6	10.0	22.5
3	42.8	4.7	9.2	22.8
4	38.5	5.0	8.1	23.8
5	42.4	4.4	9.6	26.3
6	41.6	5.3	10.4	22.1
7	38.6	3.3	6.4	19.6

DISCUSSION.

Little has been obtained from this experiment that would lead to the recommending of summer pruning in the red raspberry plantation. Indeed the indications are that EARLY summer pruning of the new shoots is more likely to be harmful than helpful, when judged by its influence on the current season's production. Certainly it is clear that effort to increase yield and improve the size of the berry can be more profitably spent in ways other than summer pruning. Any treatment involving their early reduction in number will cause a lowering in the current season's yield.

Early vigorous canes have shown marked superiority over the late season canes. In this experiment there was a difference of 32.6 grams per cane in favor of the early cane.

Pinching treatments have not proved as beneficial as was anticipated. Pinching alone, without any further treatment, proved detrimental to the cane. On the other hand pinching coupled with the removal of the surplus new shoots in the middle of the season resulted in material benefit. It would appear therefore that the new shoots

are, to a certain degree, competitive, not with the fruiting canes, but with each other; a removal of the surplus results in much larger canes with more laterals and a greater fruiting surface.

Five out of the seven treatments employed increased the total weight of the crop, primarily by increasing the total number of berries, but also by sustaining the average weight of berry throughout the season on a higher level than that of 1924. However, further experimentation will have to be done before it can be shown that this slight increase is significant enough to warrant the additional time and labor.

A C K N O W L E D G M E N T S.

The writer wishes to express his indebtedness to Professor V. R. Gardner for his assistance in planning and carrying on this investigation; to Dr. J. W. Crist for directing the analytical work and helping with the interpretation of data; and to Mr. E. F. Palmer of the Horticultural Experiment Station, Vineland Station, Ontario, for his sanction and aid in carrying out this investigation as a Station project.

SUMMARY.

1. The recommendation for summer pruning the red raspberry plantation cannot be made on the basis of this experiment.

2. Early maturing canes have given better yields than late maturing canes.

3. Excessive new shoot growth is competitive, not with the fruiting canes, but with each other.

4. Removal of surplus new shoots at the time of old cane removal was the best summer pruning treatment employed.

5. Pinching, when not accompanied by a removal of the surplus new growth proved a detriment to the plant.

6. Thinning of the new shoot growth resulted in a larger cane with a greater percentage of laterals and consequently a larger fruiting surface.

7. No correlation was found between the composition of the canes in the fall and their fruit production the following summer.

L I T E R A T U R E C I T E D.

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1. Baker, C. R. - "Practical and Scientific Fruit Culture" 1866. P. 337.

2. Barry, Patrick - "Fruit Garden". 1883. P. 314.

3. Beadle, D. W. - "Canadian Fruit, Flower, and Kitchen Gardener" 1872. P. 174.

4. Card, F. W. - "Raspberries and Blackberries" Cornell Bul. 57, 1893.

5. Fuller, A. S. - "The Small Fruit Culturist" 1867. P.134.

6. Johnston, S. and Loree, R. E. - "Pruning the Red Raspberry unpublished manuscript. M. S. C.

7. Lewis, C. I. and Cole, C. A. - "Culture of Small Fruits" Oreg. Agr. Exp. Sta. Bul. 105, 1909.

8. Reihl, A. - Trans. Ill. Hort. Soc. VOL. XVIII - 1884, P 51.

9. R. I. Experiment Station Bul. 27, 1894.

10. Roe, E. P. - "Success with Small Fruits". 1880.

11. Thomas, J. J. -"The American Fruit Culturist" 21st ed. 1903.

12. Taylor, O. M. -"Varieties of Raspberries and Blackberries with Cultural Directions". N. Y. Agr. Exp. Sta. Bul. 278, 1906.

13. Thornber, W. S. - "Raspberries, Blackberries and Loganberries in Washington". Wash. Bul. 87. 1909.