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Filler Apple Trees

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FILLER APPLE TREES

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The desirability of setting filler trees in an apple orchard is one of the questions every grower faces who plants an orchard.

In 1922 two orchards were planted on the Experiment Station farm in both of which apples were used as filler trees. By the autumn of 1933, or at the end of the twelfth growing season, it was apparent that it would be necessary to restrict the filler trees by pruning. Prior to this time the filler trees had been given the same cultural treatment, including pruning and fertilization, as the permanent trees.

To secure some measure of the worth of the filler trees in these orchards data on the size of the trees at the end of the 12-year period, the total production of fruit, and the cost of growing the trees during the period are presented.

Individual tree records were kept of the fruit produced each year; also growth measurements were taken of each tree several times during the 12-year period. Although the area covered by the two orchards was only 10.8 acres, the detailed individual yield and growth records available for study were much more complete than would be true of the average commercial orchard.

Each of these two orchards was planted for definite experimental projects. However, since the regular plot work in each orchard ran counter to the variety layout, it was also possible to use a considerable amount of the data from these orchards in the study of filler trees.

In general, the treatment given the orchards during the 12-year period would compare favorably with that given well cared for commercial orchards. The spray treatment given the trees before they started to bear was just sufficient to keep the foliage free from disease or insect ravages. After the trees began to bear fruit they were sprayed in accordance with good commercial practice. The amount of fertilizers used would be about the average recommended for commercial orchards. Orchard J was cultivated for the first few years and then maintained in sod. Orchard K was cultivated and an occasional cover crop turned under. Orchard J being on a slightly higher elevation than K was apparently a little freer from spring frost damage. The pruning given throughout the period would be rated as rather light. No heading back or restricting of lateral growth was done.

ORCHARD J

In Orchard J, embracing 6.6 acres, the permanent trees were set 40 feet apart by the square method and filler trees planted between the permanent trees in one direction. Thus, the trees in Orchard J when planted stood 40 feet by 20 feet. The permanent trees were Baldwin and Stayman. Between each two Baldwin trees a Wealthy was set and between each two permanent Stayman a Stayman tree was set.

Throughout the 12-year period permanent and filler trees were given the same treatment in every way. Although the Wealthy trees were much smaller than either the Baldwin or Stayman they received the same amount of fertilizer per tree.

SIZE OF TREES

Up to the end of the twelfth growing season no heading back of the lateral branches had been done. However, it will be seen from Table 1 that the Stayman permanent and filler trees had begun to interlace considerably. By the end of the tenth growing season it was no longer possible to drive a team between filler and permanent Stayman trees. By the end of the twelfth growing season spraying around the trees was very difficult and pickers were handicapped in harvesting the fruit.

During the winter prior to the beginning of the thirteenth growing season it was necessary to head back the Stayman filler trees rather heavily and the Wealthy somewhat less severely.

The diameter and height of the average tree of the three varieties are shown in Table 1. To determine the diameter of the head two measurements were taken of each tree and the average of these two measurements recorded as the diameter of that tree. The measurements given in Table 1 are, in turn, the average for the number of trees indicated.

TABLE 1.—Diameter and Height of Apple Trees—Orchard J

Trees planted April 1922; measurements taken January 1934

Variety	Trees measured	Diameter of head	Height
	No.	*Ft.*	*Ft.*
Wealthy	69	16.7	16.8
Baldwin	94	21.5	18.1
Stayman, permanent	79	21.4	18.6
Stayman, filler	76	21.3	18.8

From the diameter of the heads, as shown in Table 1, it will be noted that the average permanent and filler Stayman trees standing side by side would have required 42.7 feet of space to avoid interlacing. Actually, 12 years after planting, the average Stayman tree in this orchard was interlacing the adjoining tree in the same row (20 feet distant) about 15 inches.

The Baldwin trees were slightly larger in diameter of head than the Stayman; whereas the Wealthy trees planted as fillers in the Baldwin row were less (only 16.7 feet in diameter). The combined diameters of a Baldwin and Wealthy tree occupied a space of 38.2 feet. The difference in size of Wealthy and either Stayman or Baldwin emphasizes the importance of varietal habit of growth in selecting filler trees. A variety having a characteristic small tree can be left standing as a filler longer than a medium sized or large tree. Production over a greater number of years would tend to compensate for heavier production from larger trees over a shorter period of time. It has been previously shown (1) from records of older trees in the Station orchards that the Wealthy tree is one of the smallest among the common varieties. Baldwin at 31 years from planting had a spread of 34.4 feet whereas Wealthy averaged only 25.7 feet in diameter.

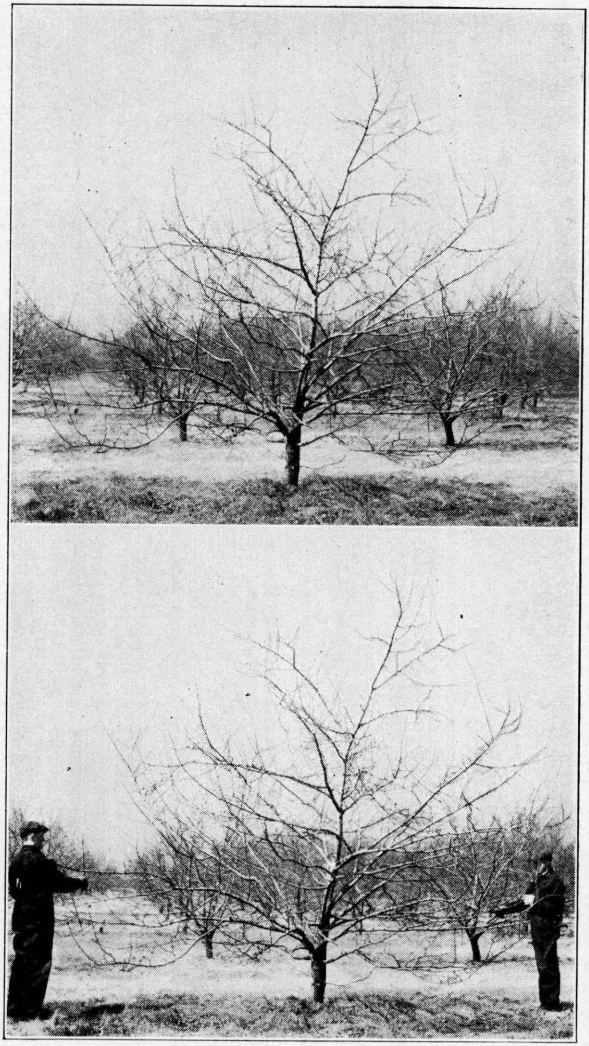

Fig. 1.—*Upper*—12-year-old filler Stayman, Orchard J. Before heading back. *Lower*—12-year-old filler Stayman, Orchard J. Being headed back.

YIELD OF FRUIT FIRST 12 YEARS

Early and heavy productions are essentially necessary in any variety used for fillers. Both Wealthy and Stayman are generally rated as early bearing varieties and this rating is borne out by the yield records shown in Table 2.

A rather surprising fact shown in Table 2 is that Baldwin, which is generally rated as slow to come into bearing, had at the end of the twelfth growing season produced more apples per tree than Wealthy. Yield records previously published (1) have shown that, on a per tree basis, Baldwin can be expected to outyield Wealthy materially. However, it was not expected that a Baldwin tree would surpass the early bearing Wealthy in the first 12 years. The spread of the tree should be kept in mind, however. It is quite evident that many more Wealthy trees could be planted on a given area than Baldwin.

TABLE 2.—Average Production per Tree
Trees planted 1922

Variety	No. of trees	No. of trees	Average weight per tree, in lb.							Total production per tree first 12 years, in lb.
Year ☞	1927	1933	1927	1923	1929	1930	1931	1932	1933	
Wealthy.....	81	69	10.8	6.5	63.0	46.1	198.5	55.8	211.8	592.5
Baldwin.....	96	94	0.9	0.3	20.1	62.2	120.0	289.2	221.5	714.2
Stayman, permanent	88	79	10.8	2.9	48.2	98.6	257.3	127.1	291.5	836.4
Stayman, filler	78	76	13.6	3.0	51.7	110.8	261.7	115.8	298.1	854.7

BEARING HABIT OF VARIETIES

From the average annual production record as shown in Table 2 it would appear that the Wealthy trees in this orchard show a decided tendency towards biennial bearing. The record of the Stayman trees indicates heavy and moderate crops in alternate years. Baldwin is generally considered an alternate heavy and light producer, or even biennial. In this orchard Baldwin seems to have been for this 12-year period fairly regular in bearing habit, although slower in reaching bearing age. A more detailed study of the bearing habits of the three varieties is presented in Table 3. For this study the individual trees were divided into four classes: (a) Trees which bore annual crops without a great deal of variation in the weight of fruit per tree from year to year; (b) trees which bore alternate heavy and light crops—a light crop in this instance being considered a production of at least 50 pounds per tree during the last 4 years of the period; (c) trees which were definitely biennial in bearing—in this instance a biennial bearing tree is one that bore at least a medium sized crop one year and the next year less than 50 pounds of fruit; (d) trees which, at the end of the 12-year period, had failed to produce even a fair sized crop, or a maximum of 100 pounds in a single year.

From the classification presented in Table 3, it is evident that the Wealthy had to a very large extent already developed a biennial bearing habit. This factor plays an important part in the average annual yield, as well as the total production per tree, during the period the filler trees remain in the orchard. The Baldwin trees in this orchard were considerably less inclined to bear biennially than Wealthy. Stayman it will be noted had a much greater pro-

portion of its trees bearing crops either annually or alternately than did either Baldwin or Wealthy. Varieties tending to be annual in bearing habit, or at least alternate, are preferable to varieties with biennial tendencies for filler trees.

TABLE 3.—Bearing Habit of Varieties—Orchard J
Including 12th year from planting

Variety	Total trees	Trees bearing annual crops	Trees bearing alternately	Trees bearing biennially	Trees consistently bearing light crops
	No.	*No.*	*No.*	*No.*	*No.*
Wealthy	69	7	18	41	3
Baldwin	94	35	30	27	2
Stayman, permanent	79	46	25	6	2
Stayman, filler	76	32	30	11	3

GROWING COSTS OF TREES FIRST 12 YEARS

Table 4 shows the growing cost per tree for the first 12 years of the average tree in Orchard J. These cost data are for the average of the three varieties and do not differentiate between filler and permanent trees since both were given the same treatment the first 12 years. There would be, of course, some difference in the growing cost of a variety having a large tree like Baldwin as compared with Wealthy. This would be especially true of such items of cost as pruning, fertilizing, and spraying. It was not possible from the records available to separate costs by variety.

ADDITIONAL CHARGES AGAINST FILLER TREES

In addition to the detailed items of cost shown in Table 4 there are other items which should be charged against filler trees: (a) It is evident that after 10 or 12 years filler trees will require more pruning than permanent trees. (b) When the trees are finally taken out an additional charge will have to be made for removing them. (c) In the case of filler trees untrue to name, especially if the varieties are inferior or of a different season than those

TABLE 4.—Growing Costs per Tree—Orchard J

Year ☞	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	Total
	Dol.	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*
Tree	0.350	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.350
Planting	.120	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.120
Cultivation and mowing	.213	0.384	0.260	0.112	0.145	0.082	0.195	0.225	0.054	0.057	0.078	0.043	1.848
Pruning	.....	.007	.095	.010	.022	.022	.038	.046	.100	.200	.142	.124	.806
Spraying	.....	.....	.028	.127	.083	.179	.300	.510	.550	.520	.570	.510	3.437
Rodent protection	.015	.015	.015	.015	.015	.015	.016	.016	.016	.016	.....	.....	.154
Fertilizer	.005	.010	.015	.020	.025	.030	.035	.040	.045	.050	.055	.060	.390
Cover crop seed	.103	.038	.024	.040	.057	.023	.080	.165	.....	.....	.....	.....	.530
Thinning	.....	.....	.....	.....	.....	.....	.....	.....	.....	.120	.080	.150	.350
Picking	.....	.....	.....	.....	.....	.016	.006	.094	.130	.178	.130	.216	.770
Grading and use of crates	.....	.....	.....	.....	.....	.016	.006	.088	.151	.332	.244	.364	1.201
Total cost	.806	.454	.437	.324	.347	.383	.676	1.244	1.046	1.473	1.299	1.467	9.956

selected, the expense will usually be greater and the income less than would have been true had the trees all been true to name. Trees untrue to name are bad enough under any condition, but permanent trees may be top-worked while this is hardly justified in the case of filler trees. (d) Small or subnormal filler trees may not produce enough fruit during the time they remain in the orchard to cover the growing costs. Such trees are a liability and add to the growing costs of the entire number of filler trees.

Since restrictive pruning on the filler trees in this orchard was not begun until the trees had finished the twelfth year, no data are available on the extra pruning costs. Neither are data available on cost of removing the trees in this orchard.

In Table 5 will be found a summary of the growing costs of permanent and filler trees. In this table is also shown the cost of growing the untrue trees and those which died before the end of the twelfth year. It will be noted that there were 10 trees not true to name out of the 90 Wealthy trees originally planted. These trees were all Oldenburg. There were two trees among the 81 filler Stayman untrue, both of them Winesap.

TABLE 5.—Summary of Growing Costs—Orchard J
First 12 years; 6.6 acres

	Wealthy	Baldwin	Stayman, permanent	Stayman, filler	Total
No. of trees planted	90	100	90	81	361
No. of trees not true to name	10	2	8	2	22
No. of dead trees first 12 years	11	2	3	3	19
No. of subnormal trees	.....	2	.....	.....	2
No. of normal trees	69	94	79	76	318
Cost of growing normal trees	$687.24	$936.24	$786.84	$756.96	$3167.28
Cost of growing trees untrue to name	95.36	19.92	79.68	19.92	214.88
Cost of growing trees which died first 12 years	59.45	5.93	17.63	15.29	98.30
Cost of growing subnormal trees	.....	15.27	.....	.....	15.27
Total cost of growing	842.05	977.36	884.15	792.17	3495.73
Total cost per acre	.....	.....	.....	.....	529.66

VALUE OF FRUIT PER TREE

In Table 6 is shown the value of the apples produced on the average tree of the three varieties in Orchard J through the twelfth year from planting. The figures shown in this table are calculated by using the prevailing prices for the various grades of apples in the Wooster area for this period of years. There was practically no difference in the basic selling price per bushel between varieties, and, hence, the three varieties are grouped together as far as price for any grade is concerned. The value of the fruit per tree shown in Table 6 takes into consideration the grade, quantity produced per tree, and the prevailing price from year to year.

TABLE 6.—Value of Fruit per Tree—Orchard J
Planted 1922

Year ☞	1927	1928	1929	1930	1931	1932	1933	Total
	Dol.	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*
Wealthy	0.41	0.22	2.67	1.42	1.98	0.80	4.28	11.78
Baldwin	.004	.01	.83	2.01	1.19	4.28	4.44	12.76
Stayman, permanent	.41	.10	2.02	3.16	2.57	1.91	5.83	16.00
Stayman, filler	.52	.11	2.17	3.55	2.61	1.74	5.96	16.66

VALUE OF FRUIT FOR FIRST 12 YEARS

In Table 7 an effort has been made to summarize the value of the fruit produced in Orchard J for the first 12 years. In this table will be found the value of the fruit produced from the trees untrue to name, as well as from the normal trees. In placing a value on the fruit from the trees untrue to name it was estimated that this fruit would be worth 75 per cent as much per pound as that from the normal trees. The total weight of the fruit produced on the trees untrue to name was used in determining the total value of this fruit. The varieties substituted were in every instance worth less than the variety which had been selected, and, moreover, the inconvenience of picking and handling these odd varieties added considerably to growing costs.

TABLE 7.—Value of Fruit—Orchard J
First 12 years; 6.6 acres

Variety ☞	Wealthy	Baldwin	Stayman, permanent	Stayman, filler	Total
	Dol.	*Dol.*	*Dol.*	*Dol.*	*Dol.*
Value of fruit from trees true to name	812.82	1199.44	1264.00	1266.16	4542.42
Value of fruit from trees not true to name	49.24	8.56	65.14	9.28	132.22
Value of fruit from trees which died 1st to 12th years	17.93	0.04	5.77	7.34	31.08
Total value of fruit from normal, untrue, and dead trees	879.99	1208.04	1334.91	1282.78	4705.72
Total cost of growing above trees 1st to 12th years	842.05	977.36	884.15	792.17	3495.73

VARIETIES COMPARED

In this particular orchard Wealthy gave a much less favorable response than did Stayman as a filler tree. This was partly due to the fact that there were many more trees untrue to name in the Wealthy planting and also a much higher mortality than was true among the Stayman fillers. In placing values on these two varieties as fillers it should be kept in mind that Stayman trees were larger than the Wealthy and will, for the few years they remain as fillers, require more severe pruning than Wealthy. It is probable that the yields from the two varieties will be more nearly equal in the next few years. One of the disadvantages of Wealthy as a filler is the tendency towards alternate or biennial bearing. The value of the Wealthy for the 12 years exceeded the growing costs by $37.94, and the Stayman fillers had a value of $490.61 more than the growing cost. The filler trees in this orchard of 6.6 acres showed a total value of $528.55, or $80.08 per acre above the growing costs.

OVERHEAD CHARGES NOT INCLUDED

It should be pointed out that the growing costs in this instance do not include such overhead charges as taxes, interest on investment, supervision, and buildings. Whether or not any charge for such items should be made against filler trees is open to question. However, the cost of removing the filler trees should be charged against the filler trees. If such a charge had been made against the Wealthy fillers at the end of the twelfth year, there would have remained very little margin above the growing costs. However,

allowing for a liberal charge for removing the trees, the Stayman fillers would have paid a good margin above the costs in growing them. This emphasizes the necessity of selecting with care varieties to be used as fillers.

ROOT DISTRIBUTION

During the tenth growing season trenches were dug to ascertain the extent of the distribution of roots in this orchard. It was found that the roots were extending outward for more than 20 feet, or over half way to the next tree row. This would mean that 10 years from planting the roots from these trees were overlapping the roots from the trees adjacent in the same row (a distance of 20 feet). Just how soon this overlapping of root systems will be reflected in the behavior of the trees is not known. In this particular orchard it seems likely that 15 years will be the maximum length of life of the filler trees.

ORCHARD K

The first planting in Orchard K was made in the spring of 1922. Because of the dimensions of the tract of land where this orchard is located the rows are only 38 feet apart. The permanent trees stand 40 feet apart in the rows. Permanent varieties are Stayman and Jonathan. Filler varieties are McIntosh and Grimes.

In the spring of 1923 a row of filler trees 20 feet apart was planted between each two permanent rows. The varieties used in this filler row were Stayman, Grimes, Arkansas, and Winesap. Thus, from 1923 until the fall of 1931, the distance between the rows in Orchard K was 19 feet and between the trees 20 feet.

SIZE OF TREES

It should be pointed out here that the filler row was planted primarily for other purposes than a study of filler trees. By the fall of 1931 the trees were so large that it was very difficult to drive a team between the rows and therefore the filler row was removed.

Measurements of the spread of the trees in this filler row removed in 1931 were taken just before they were removed. These data are shown in Table 8.

Of the four varieties planted in the filler row three can be rated as medium sized trees; whereas Arkansas has a rather spreading habit of growth. It will be seen that even with the smaller of these varieties (Grimes) 9 years after planting restrictive pruning would have been necessary to allow a sprayer and other implements to be drawn through the orchard.

TABLE 8.—Diameter of Heads of 9-year-old Trees

Variety	Average diameter of head of trees
	Ft.
Stayman	18.2
Winesap	19.9
Arkansas	20.2
Grimes	17.4

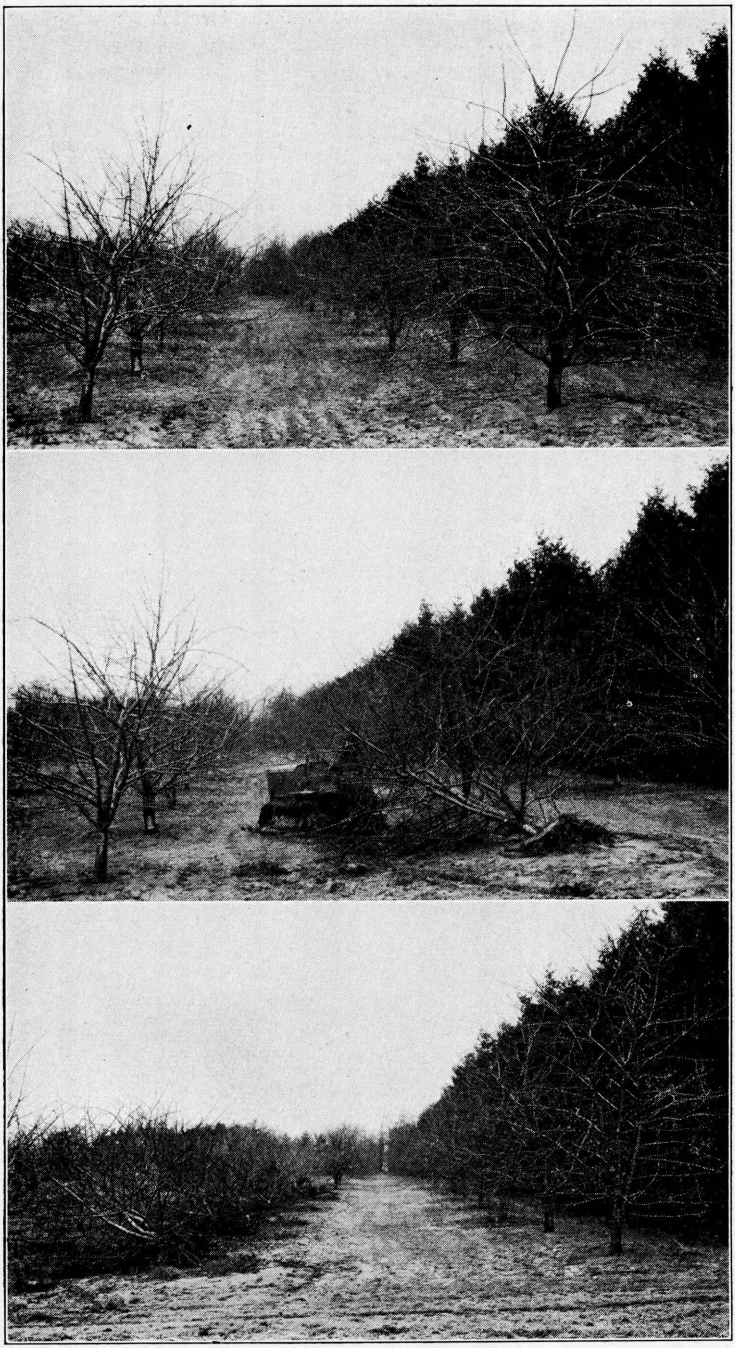

Fig. 2.—*Upper*—Orchard K. Before filler rows were removed. *Middle*—Removing filler trees from Orchard K. *Lower*—Orchard K after filler row had been removed

During the winter of 1933, or at the end of the twelfth growing season, it was necessary to begin heading back the filler trees remaining.

The tree measurements taken after the twelfth growing season are shown in Table 9.

TABLE 9.—Diameter and Height of Trees—Orchard K
Trees set April 1922; measurements taken January 1934

Variety	Trees measured	Av. diameter of head	Av. height of head
	No.	*Ft.*	*Ft.*
Stayman	55	19.7	18.5
McIntosh	49	21.1	20.0
Jonathan	53	18.3	18.4
Grimes	41	18.5	18.3

The McIntosh trees were the largest of the four varieties at the end of the 12-year period. The Stayman trees in Orchard K were not so large as Stayman trees of the same age in Orchard J. Both Jonathan and Grimes trees in Orchard K were appreciably larger than Wealthy trees in Orchard J.

YIELD OF FRUIT FROM FILLER ROWS

The average production per tree from the filler rows the first 9 years is shown in Table 10.

TABLE 10.—Production of Fruit from Filler Rows for First 9 Years—Orchard K

Variety	Yield
	Lb.
Stayman	330.7
Winesap	251.4
Arkansas	418.2
Grimes	315.3

The yield of the permanent rows through the twelfth growing season is shown in Table 11.

TABLE 11.—Average Production per Tree—Orchard K
Trees planted 1922

Variety	No. of trees, 1927	No. of trees, 1933	1927	1928	1929	1930	1931	1932	1933	Total
			Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Stayman	59	55	1.9	5.8	34.2	99.4	188.8	151.2	176.5	657.8
McIntosh	55	49	3.7	13.1	39.7	117.7	130.8	189.5	270.7	765.2
Jonathan	55	53	10.9	35.0	36.0	137.6	229.4	89.5	297.8	836.2
Grimes	54	41	12.5	23.0	24.2	127.1	123.9	227.1	154.1	691.9
Average										737.8

Comparing the yields of the 12-year-old trees in Orchard K (Table 11) with those of trees of the same age in Orchard J (Table 2) it will be noted that the average of all varieties in Orchard K is only a little less than that in J. There is less difference between the high and low yielding varieties in K than J. The yield of Stayman, the only one of the six varieties in both orchards, was 188 pounds per tree greater in Orchard J than in Orchard K for the 12-year period. Orchard K, because of its location, was probably subject to more frost injury than Orchard J. Stayman being rather susceptible to spring frost injury probably suffered more in Orchard K than in Orchard J.

BEARING HABIT

Using the same standard of measurement as was used to define regularity of bearing in Orchard J (Table 3), the varieties grown in the permanent rows in Orchard K are classified in Table 12.

TABLE 12.—Bearing Habit of Varieties—Orchard K
Including twelfth year from planting

Variety	Total trees	Trees bearing annual crops	Trees bearing alternately	Trees bearing biennially	Trees consistently bearing light crops
	No.	*No.*	*No.*	*No.*	*No.*
Stayman	55	27	14	4	10
McIntosh	49	23	14	5	7
Jonathan	53	17	23	9	4
Grimes	41	17	8	11	5

Although permanent bearing habits can hardly be expected to be fully developed by the twelfth growing season, it is of interest to note that Stayman showed about the same proportion on alternate bearing trees in Orchard K as in J. Jonathan was beginning to show a tendency towards alternate cropping. On the whole, there were more trees which had not yet borne a heavy crop in Orchard K than in J. This may have been due to Orchard J being less susceptible to frost injury than K. This serves to emphasize the importance of the advantage of using filler trees that are comparatively free from frost injury. A filler tree should bear early and regular crops in the first 15 or 20 years, and a variety susceptible to frost injury is even more undesirable for a filler tree than for a permanent tree. In the case of a permanent tree which is expected to bear fruit for 40 or 50 years there is more chance over the longer period of fruiting to compensate for frosty years.

GROWING COST OF TREES FOR FIRST 12 YEARS

The growing costs per tree in Orchard K are shown in Table 13. These data are for the average tree regardless of variety. Here, as in Orchard J (Table 4), no account is taken of overhead costs, and this fact should be kept in mind in any interpretation given these figures. The average growing cost per tree in this Orchard (K) was somewhat less than in J. Only a small amount of cover crop seed is included in the cost items. Such items as picking and grading which are based on total yield were lower in K than J, because the average tree yield was slightly lower.

TABLE 13.—Growing Costs per Tree—Orchard K

Year ☞	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	Total
	Dol.	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*
Tree	0.350	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.350
Planting	.120	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.120
Cultivation	.193	0.378	0.248	0.057	0.072	0.079	0.082	0.099	0.036	0.055	0.174	0.128	1.601
Pruning	.....	.007	.095	.010	.022	.022	.038	.046	.100	.220	.142	.....	.702
Spraying	.....	.....	.025	.135	.100	.157	.300	.570	.050	.450	.540	.740	3.067
Rodent protection	.015	.015	.015	.015	.015	.015	.016	.016	.016	.016	.....	.....	.154
Fertilizer	.005	.010	.015	.020	.025	.030	.035	.040	.045	.050	.055	.060	.390
Cover crop seed	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.031	.051	.082
Thinning	.....	.....	.....	.....	.....	.....	.....	.....	.....	.100	.149	.....	.249
Picking	.....	.....	.....	.....	.....	.013	.038	.054	.162	.147	.135	.190	.739
Grading, hauling, and crate rental	.....	.....	.....	.....	.....	.012	.036	.063	.226	.275	.256	.321	1.189
Total	.683	.410	.398	.237	.234	.328	.545	.888	.635	1.313	1.482	1.490	8.643

Such items of cost as pruning and spraying were greater in J than K, mainly because the trees in J were somewhat larger. Very little thinning was done in K for the first 12 years. Taking into consideration both orchards, J and K, the average growing cost per tree for the 12-year period was $9.30.

In Table 14 is shown a summary of the growing costs for Orchard K. No consideration is given in this table to the filler rows which were removed in 1931. An attempt has been made in this table, as in Table 5, to separate normal trees from subnormal trees and untrue varieties and to include the cost of growing the trees which died during the first 12 years.

TABLE 14.—Summary of Growing Costs—Orchard K
First 12 years; 4.2 acres (Filler rows not included)

	Stayman	McIntosh	Jonathan	Grimes	Total
No. of trees planted	64	56	56	56	232
No. of trees not true to name	5	1	1	2	9
No. of dead trees first 12 years	4	6	2	13	25
No. of subnormal trees	6	4	1	4	15
No. of normal trees end of 12 years	49	45	52	37	183
Cost of growing normal trees	$423.36	$388.80	$449.28	$319.68	$1581.12
Cost of growing trees untrue to name	38.90	8.64	8.64	17.28	73.46
Cost of growing trees which died first 12 years	18.70	31.73	8.72	75.58	134.73
Cost of growing subnormal trees	51.84	34.56	8.64	34.56	129.60
Total cost of growing	532.80	463.73	475.28	447.10	1918.91
Total cost per acre	.....	.....	.....	.....	456.88

It will be noted that the acre cost in Orchard K was $456.88 per acre and in J, $529.66.

VALUE OF FRUIT PER TREE

The value of the fruit grown on the average tree the first 12 years is shown in Table 15. This value is calculated in the same manner as in Orchard J (Table 6), except that the price per pound for McIntosh was generally higher than for the other varieties—Stayman, Jonathan, and Grimes.

TABLE 15.—Value of Fruit per Tree—Orchard K
Planted 1922

Variety	1927	1928	1929	1930	1931	1932	1933	Total
	Dol.	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*
Stayman	0.07	0.23	1.39	3.04	1.88	2.16	3.39	12.16
McIntosh	.16	.45	2.03	4.74	2.39	3.79	6.78	20.34
Jonathan	.41	1.20	1.48	4.33	2.28	1.32	5.87	16.89
Grimes	.48	.81	1.02	4.01	1.27	3.50	3.16	14.25
Average value per pound all grades McIntosh	.038	.035	.052	.04	.018	.02	.025	.....
Average value per pound all grades other varieties	.038	.035	.042	.032	.01	.015	.020	.....

VALUE OF FRUIT FIRST 12 YEARS

The value of the apples produced on the filler tree plantings (McIntosh and Grimes) in Orchard K exceeded that of the permanent trees (Stayman and Jonathan) for the first 12 years (Table 16). In nearly all instances the trees not true to name in Orchard K were less valuable than the variety ordered. More fruit was salvaged over the 12 years from trees that died during the period in K than in J. The value of the fruit per acre in K for the 12 years was $747.88 as compared with $712.99 per acre for J.

TABLE 16.—Value of Fruit—Orchard K
First 12 years; 4.2 acres

	Stayman	McIntosh	Jonathan	Grimes	Total
	Dol.	*Dol.*	*Dol.*	*Dol.*	*Dol.*
Value of fruit from trees true to name	595.84	915.30	878.28	527.25	2916.67
Value of fruit from trees not true to name	13.08	7.25	3.18	16.73	40.24
Value of fruit from trees which died first 12 years	10.34	35.78	1.83	109.64	157.59
Value of fruit from subnormal trees	10.57	9.37	2.42	4.25	26.61
Total value of fruit from all trees	629.83	967.70	885.71	657.87	3141.11
Total cost of growing trees first 12 years	532.80	463.73	475.28	447.10	1918.91

INFLUENCE OF VARIETY ON VALUE OF FRUIT

It will be noted from Tables 2 and 11 that during the 12-year period the average Baldwin tree had produced a total of 714 pounds and the average Grimes tree had borne only 692 pounds. The income from the average Baldwin tree (Table 6) was $12.76 and that of the average Grimes was $14.25 (Table 15). The selling price of the several grades of the two varieties over the period was the same. The advantage in total income of the Grimes over the Baldwin is explained by the fact that Grimes came into fair production during years when apples were high, while Baldwin did not reach heavy production until the price had declined below the level prior to 1930.

McIntosh ranked first in average income per tree, although the yield was not so great as that of either Jonathan or Stayman. This is due to the higher selling price per bushel of McIntosh as compared with the other two varieties. This fact serves to emphasize the relationship between the selling price of a variety and its adaptability as a filler.

COST OF REMOVING TREES

Since the filler trees are still standing in Orchards J and K no exact information is available as to the cost of removing these filler trees. In removing the filler row in Orchard K in 1931 a tractor using a direct hitch pulled 177 9-year-old trees in 4 hours and 15 minutes. Allowing 85 cents per hour for the tractor use, 6 gallons of gasoline, 1 quart of oil, and the time of two men at the rate of 40 cents per hour, the cost for pulling was $0.048 per tree.

Unfortunately, there is no record available of the cost of hauling out the trees and burning the brush. There is considerable hand work involved in such labor, and no doubt the pulling of the trees represented not more than one-fourth of the entire expense involved in removing these filler rows. It was rather easy to pull these 9-year-old trees out with a direct hitch. The filler trees remaining will doubtless have to be removed at the end of the fifteenth or sixteenth years' growth. Fagan (3) reported the removal of filler trees at the end of the sixteenth year. Pulling out 16-year-old trees by the roots frequently requires the use of a tackle. This will slow up the work and increase the expense. Some orchardists have been able to trade the wood to men to be used for fuel as at least partial payment for labor in removing the trees.

In sod orchards where no cultivation is contemplated the filler trees may be sawed off level with the surface of the ground thus expediting the task of removing the trees and also materially reducing the cost.

In the use of filler trees this cost of removal should always be considered. Only for the filler rows in Orchard K has any account been taken of this item of cost in the data presented here.

HAVE THE FILLER TREES BEEN PROFITABLE?

In Table 17 is presented a condensed summary of the value of the fruit produced on permanent and filler trees in Orchards J and K for the 12-year period. In this table is also shown the cost of growing these trees. No accurate record of overhead costs in these orchards is available.

TABLE 17.—Profit and Loss—Orchards J and K
First 12 years; 10.8 acres

	Orchard J—6.6 acres				Orchard K—4.2 acres			
	Value of fruit	Growing and harvesting costs	Overhead cost estimated	Total cost	Value of fruit	Growing and harvesting cost	Overhead cost estimated	Total cost
	Dol.	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*
Permanent trees	2542.95	1861.51	930.76	2792.27	1515.54	1008.08	504.04	1512.12
Filler trees	2162.77	1634.22	.....	1634.22	1625.57	910.83	.....	910.83
Filler rows	.....	.....	.....	.....	1577.89	868.00*	.....	868.00
Total	4705.72	3495.73	930.76	4426.49	4719.00	2786.91	504.04	3290.95

*Cost of removing filler rows (estimated) included in this item.

In other published data—Waller (7), Johnson (4), Merchant (5), Scoville (6), and Ellenwood(2) —it has been shown that the overhead charges in bearing orchards range from one-fourth to somewhat more than one-third the total costs. These overhead charges include such items as taxes, depreciation on buildings, interest on investment, and general supervision.

In the growing costs of these two orchards it would seem fair to assume that overhead charges represented one-third the total costs. Most of the overhead should, however, be charged against the permanent trees, since the number of trees per acre would not materially affect the major items included under that head. Accordingly, the estimated overhead cost has all been added to the permanent trees.

It will be noted from Table 17 that the cost of growing the fruit on the permanent trees in Orchard J for the first 12 years exceeded the value of the fruit by $249.32. However, when fruit from the filler trees was taken into consideration there was a favorable balance for the orchard of $279.23 for the 12-year period.

In Orchard K the value of the fruit on the permanent trees exceeded the growing costs by $3.42. With filler trees and filler rows added to the permanent trees the value of the fruit exceeded total growing costs by $1,428.05.

Thus, in these two orchards it may be said that in J the filler Wealthy and Stayman trees were responsible for this orchard showing a profit. In K the cost of growing the permanent trees was practically the same as the value of the fruit, and the filler trees and filler rows were responsible for a very favorable balance over the total growing costs.

OTHER FACTORS WHICH INFLUENCE VALUE OF FILLER TREES

Some of the factors that influence the value of filler trees not discussed in detail here are:

1. The valuation of the land.

   The necessity for maximum income during the early years of the life of an orchard is more urgent where the trees are located on high priced land.

2. Fertility of soil.

   It seems obvious that filler trees would not be practical in orchards set on land of medium or low fertility. If a soil building program is necessary in a young orchard, filler trees are not desirable. At least no more than a tree in the center of a 35 or 40-foot tree square would seem advisable.

3. Taxes.

   Where orchard sites have high tax valuation there is more necessity for fillers than where taxes are relatively low.

4. Price per bushel.

   Filler trees naturally show a much greater return during a cycle of years when the price per bushel is high than when prices are low. Not very much can be done by the grower to regulate the current price per bushel. It is, however, at least partly within the power of the grower to produce fruit at least of medium quality.

SUMMARY

Yield and growth records of 10.8 acres of apple trees with growing costs are presented. These orchards contain both permanent and filler trees and consist of six varieties. Permanent trees were set 40 feet apart in the row with filler trees midway between.

Baldwin, McIntosh, and Stayman occupied all of the 20-foot space by the end of the twelfth growing season. Grimes and Jonathan were somewhat smaller. Wealthy was nearly 5 feet smaller in diameter of head than Baldwin or Stayman in the same orchard.

All varieties except Wealthy required restrictive pruning at the end of the twelfth growing season. Wealthy began bearing early but developed a tendency towards biennial bearing. This habit, coupled with the rather small size of the trees, made Wealthy less valuable as a filler than had been anticipated. It should be borne in mind, however, that more Wealthy trees could be planted per acre than of most other varieties.

A variety having an annual bearing habit is necessary when filler trees are set in the row with permanent trees. More toleration may be given biennial bearing filler trees set in the center of permanent squares.

Stayman trees were much larger than Wealthy and required heading back earlier. However, Stayman was more regular in bearing and more productive the first 12 years.

Mortality of trees during the early years was an important factor in determining the value of a variety for filler purposes. Mortality was highest among Grimes and Wealthy and least with Jonathan and Baldwin.

The cost of growing trees untrue to name, trees which died during the 12-year period, and those of subnormal growth exceeded the value of the fruit produced during the 12 years.

Filler row trees removed at the end of the ninth growing season had slightly more than paid their way, largely because of an exceptionally heavy yield in a single year.

The importance of using filler varieties with a high value per pound is emphasized. The average value of the fruit from McIntosh trees was greater than from any other variety because the value per pound of this variety was highest.

By restrictive pruning McIntosh filler trees can probably be maintained until the end of the fifteenth growing season, Stayman about the same length of time, and Grimes and Wealthy a year or two longer.

Taken as a whole, in the 10.8 acres of orchard, filler trees have proven profitable at the end of the twelfth growing season.

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