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Crops and Cultural Practices on Former Apple Orchard Land

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Rye on recently cleared apple orchard land

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Summary

1. Crop production on recently cleared apple orchard land is likely to be poor due to accumulation of toxic spray materials and because of poor physical condition of the soil. These conditions are especially bad in and near former tree locations.

2. Such land can be reclaimed most quickly and economically by liberal use of barnyard manure and by growing nonlegume cover crops for one or more years.

3. The best cover crops for this purpose are winter rye seeded in the fall and turned under the following spring, and Sudan grass seeded in May and turned under in late summer.

4. When the cover crops no longer are stunted materially, usually within 2 to 4 years, most tree fruits and small fruits, and several vegetable and field crops, can be grown profitably.

5. Of the row crops common to Idaho, potatoes and sugar beets usually are the first that can be grown satisfactorily. With further soil improvement, carrots, radishes, turnips, rutabagas, and lettuce, both for market and seed production, and onions for seed, can be grown.

6. Legume crops, such as alfalfa, clovers, beans, and peas usually are unsatisfactory on these soils until 5 years or longer after the trees have been removed.

Crops and Cultural Practices on Former Apple Orchard Land

LEIF VERNER AND GEORGE W. WOODBURY[1]

Introduction

IT has been the experience of fruit growers of the Pacific Northwest that soils from which mature apple orchards have been removed recently are poorly suited for the production of most crops. Fruit trees and small fruits planted on such soils often are very unthrifty. Most vegetables and many field crops either fail to survive or make such poor growth as to be unprofitable.

These old orchard lands represent a high capital investment per acre. In many cases they constitute the sole source of income of the owner or operator. It is expedient, therefore, that they be reclaimed as quickly as possible and made suitable for the production of crops of a high per acre value. Although there is normally a gradual improvement in these soils as time goes on, farming operations may be unprofitable for a number of years unless special cultural practices or cropping systems are employed.

Reported in this bulletin are the results of observations and experiments conducted in Idaho over a period of 6 years to determine the cultural practices and cropping systems that will most quickly and economically rehabilitate these soils.

Review of Literature

All of the factors that may contribute to the harmful residual effects of old apple orchards on succeeding crops have not been clearly established. There is evidence that these effects are due in a large measure to accumulation of toxic amounts of arsenic in the soil as a result of prolonged use of arsenical insecticides, which have been employed in large quantities in most apple orchards of the Northwest. Undoubtedly the situation is aggravated by the poor physical condition of the soil following the removal of large trees, and possibly by a deficiency of soil nutrients.

Verner *(6)* reported that tree fruits, small fruits, and vegetables of various kinds were affected adversely by the soil on recently cleared apple orchard land in southwestern Idaho, and that the deleterious effects were most pronounced in the immediate vicinity of the original tree locations. Snyder *(4)* described a number of cases in the Yakima and Wenatchee valleys of Washington in which failure or indifferent results attended efforts to re-establish fruit trees on old apple orchard land. Most vegetable crops, and cover crops such as alfalfa and oats, also failed or made very poor growth on such soils. All crops were much benefited, and some made moderately good growth, following liberal applications of barnyard manure. Vincent *(7)* found that growth of a number of small fruit and vegetable crops was depressed most severely on those soils from which orchards had been removed most recently. While several kinds of vegetables and small fruits responded well on land from which trees had been removed

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7 years previously, results were less satisfactory where the trees had been removed only 2 years or immediately prior to planting the test crops.

Vandecaveye, Horner, and Keaton *(5)*, working with soils from apple orchard land that failed to produce satisfactory cover crop growth following removal of old trees, found that the upper 6 inches of these soils contained from 4.5 to 12.5 p.p.m. of readily soluble arsenic as As_2O_3. Soil from a nearby field without an orchard history contained only a trace of arsenic, indicating that the rather large accumulations in the orchard soils were not natural deposits but probably spray residues. Under field conditions the growth of alfalfa and barley were in inverse proportion to the amount of soluble arsenic present. When this exceeded 2 p.p.m. in the upper 6 inches of soil, crop growth was noticeably impaired. When it exceeded 3 p.p.m. severe damage or death of the crops occurred. Morris and Swingle *(3)* observed wide differences in the arsenic tolerance of different plant species. Beans and cucumbers were especially sensitive while cereals and grasses appeared somewhat resistant.

Crafts and Rosenfels *(2)*, working with 80 soils of California, found arsenic toxicity to plants most severe in sandy types of soil and least severe in heavy clays. Natural leaching of the soil reduced toxicity through the removal of soluble arsenic.

No comprehensive study of the effects of arsenic-contaminated soils on arsenic toxicity of food plants has yet been reported in the literature. According to Williams and Whetstone *(8)*, "Soils contaminated with arsenic may, in some cases, produce vegetation of higher arsenic content than that found in any natural soil. However, in general it appears that plant growth is limited by the presence of arsenic in soils before injurious quantities are absorbed." These authors, as well as Vandecaveye, *et al, (5)*, found a greater concentration of arsenic in the roots of plants than in the tops. Vandecaveye, *et al.*, report values of 10.01 to 17.50 p.p.m. of As_2O_3 in the tops of barley plants from heavily contaminated soils, and from 788 to 1640 p.p.m. in the roots. Lead was present in the roots in amounts from 662.50 to 756 p.p.m., but the tops contained only a trace of lead.

Observations and Experiments in Idaho

The removal in 1936 of 9 acres of mature apple orchard at the University of Idaho Branch Experiment Station at Parma afforded an opportunity for a study of this problem. The trees in this orchard, which were spaced 30 feet apart on the square system, were 22 years old and of large size for their age. The history of the orchard indicated that it had been heavily sprayed with arsenicals, and soil analyses bore out this conclusion.[1]

In early April, within a month after the old trees were removed the ground was plowed, disced, and leveled; and test plantings of different kinds and varieties of tree fruits, small fruits and vegetables were made. Data resulting from these plantings have been supplemented by extensive observations of results secured by growers using a variety of crops and cultural practices on land from which apple orchards had been removed from 1 month to 5 years previously.

[1] All chemical analyses of soils from this orchard were made by the Department of Agricultural Chemistry, University of Idaho.

Experiments with Fruit Trees

Ten trees each of apple, sweet cherry, peach, apricot, and prune were planted in the exact locations of old trees in the original orchard. These will be referred to as trees growing in old tree holes. Duplicate lots of each of these kinds of trees were planted in the centers of squares formed by trees of the original orchard, and will be referred to as trees growing between former tree rows. A third lot of 10 apple trees planted in old tree holes were treated with a top dressing of one wheelbarrow load of barnyard manure per tree, applied a few days after planting.

In Figure 1 are shown all of the young trees at the end of their first growing season on old orchard land. Increases in trunk circumference of these trees over 4- to 6-year period are shown in Table 1. It is apparent from this figure and these data that trees planted between former tree rows made, for the most part, much better growth than those planted in the old tree holes. The 10 apple trees planted in old tree holes with manure added as a top dressing made considerably better growth than those planted in old holes without manure.

Of the different kinds of fruit grown, apricots made the most satis-

Table 1.—Summary of trunk circumference increments in fruit trees planted on former apple orchard land at Parma.

Kind of fruit	No. of years since planted	Mean trunk circumference increments in centimeters since planting		Odds of significance
		Trees in old tree holes	Trees between former tree rows	
Apple	1	.33 ± .17	1.49 ± .28	666:1
	2	2.2 ± .56	4.7 ± .45	555:1
	3	5.7 ± 1.14	10.0 ± .79	255:1
	4	10.5 ± 1.61	15.3 ± 1.00	78:1
	5	14.0 ± 2.35	21.2 ± 1.64	78:1
	6	18.6 ± 2.70	27.3 ± 1.90	94:1
Sweet Cherry	1	.64 ± .22	2.50 ± .28	9999:1
	2	4.4 ± .79	8.1 ± .48	1999:1
	3	11.4 ± 2.0	17.0 ± .88	107:1
	4	16.7 ± 2.85	24.8 ± 1.04	131:1
	5	27.7 ± 2.85	32.8 ± 1.18	8:1
	6	35.3 ± 2.70	39.8 ± 2.10	8:1
Peach	1	1.3 ± .28	3.6 ± .51	1999:1
	2	6.1 ± .75	9.9 ± .90	155:1
	3	18.4 ± 1.36	22.2 ± 1.13	37:1
	4	28.7 ± 1.76	33.8 ± 1.61	37:1
Apricot	1	3.2 ± 1.42	5.8 ± 1.51	1999:1
	2	12.3 ± .87	15.5 ± .66	191:1
	3	25.2 ± 1.13	26.7 ± 1.03	5:1
	4	34.2 ± 2.20	38.2 ± 1.00	17:1
Prune	1	1.7 ± .24	3.5 ± .22	9999:1
	2	7.9 ± .66	11.2 ± .41	3332:1
	3	17.0 ± 1.07	20.8 ± .42	475:1
	4	26.7 ± .92	29.3 ± .40	107:1
	5	32.8 ± .63	34.7 ± .33	131:1
	6	37.5 ± .55	38.5 ± .37	12:1

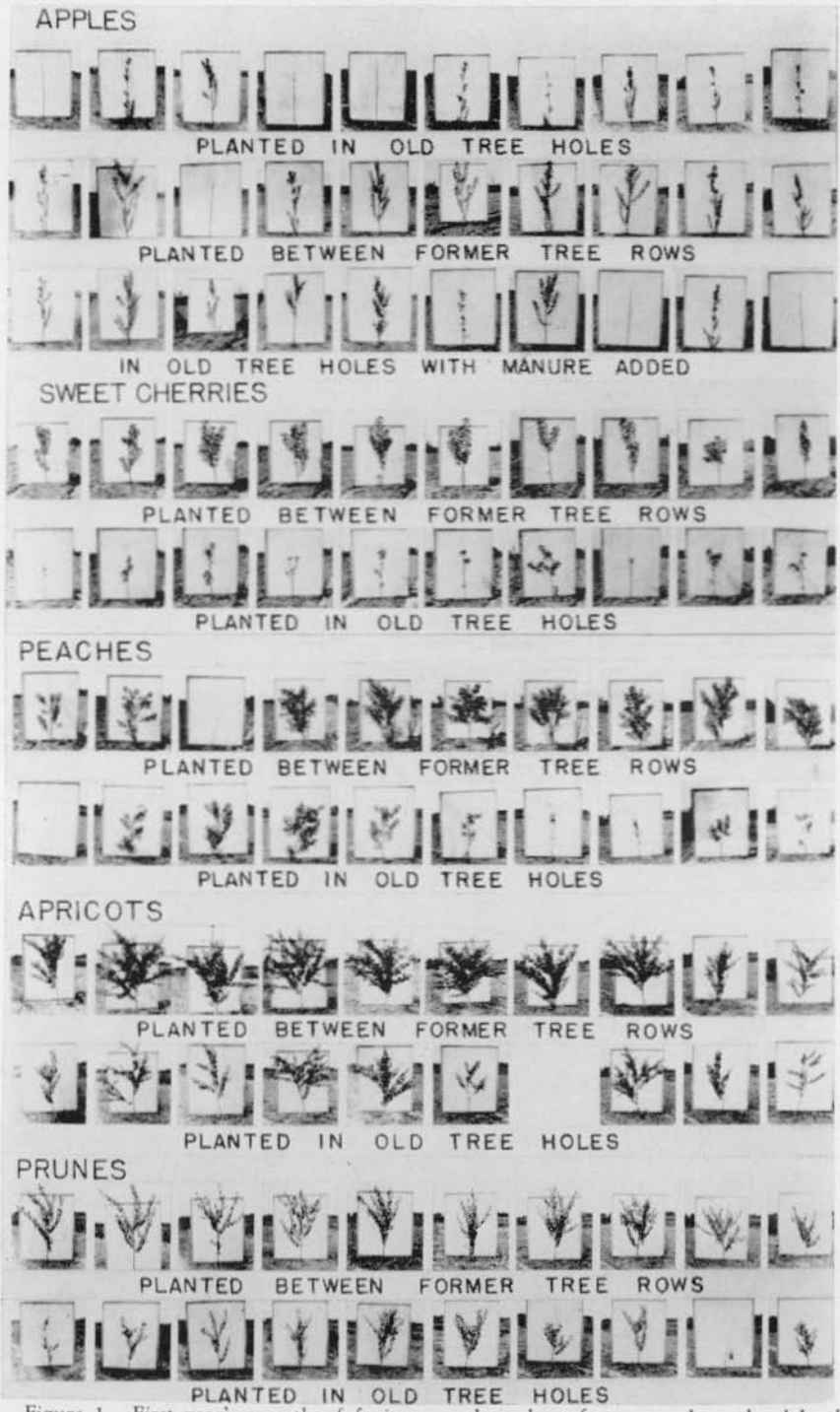


Figure 1.—First year's growth of fruit trees planted on former apple orchard land at Parma.

factory growth the first year. Both peach and prune trees made good growth the first year when planted between former tree rows, but were stunted severely when planted in old tree holes. Apple and sweet cherry trees made virtually no growth the first year in old tree holes, where they scarcely more than remained alive. When planted between former tree rows these trees generally made unsatisfactory growth and had an unthrifty appearance. At the end of the fourth growing season most of the apple and sweet cherry trees still were considerably below average size and vigor for trees of their age. All of the apricot and peach trees, and all of the prunes except those in old tree holes, were average or better in size and vigor at the end of the fourth year and would be regarded as trees potentially capable of good commercial production.

Relative differences in size between trees planted in old tree holes and those planted between former tree rows have become less each year *(See Table 1)*. Apparently, if the trees survive the initial bad effects of the soil in old tree holes, and their roots extend into a soil horizon below that of highest arsenic concentration, their subsequent growth approaches that of the trees more favorably located.

Despite this tendency for the differences between trees planted in different positions to diminish as they grow older, it is advisable to avoid planting in old tree holes if possible. The mortality rate of trees the first 2 years after planting was greater in old tree holes than between former tree rows, 15 per cent and 4 per cent, respectively, in 50 trees of all kinds in each category. The only records secured on yields, given in Table 2, showed that production of cherries in their sixth year, and of prunes in their fifth and sixth years, were significantly greater in trees planted between former tree rows than in trees growing in old tree holes. Frost destroyed the bloom on peach and apricot trees in their third and fourth years, and the experiment with these trees had to be discontinued at the beginning of the fifth year due to crowding.

From these results with tree fruits it is evident that, whatever the factors may be that contribute to the depressing effect of old apple orchard soil on crop growth, this effect is most pronounced in and near the original tree locations. Analyses of soil samples taken from 1 to 3 feet from the trunks of 10 of the old trees before they were removed showed an average soluble arsenic content of 16.6 p.p.m., as As_2O_3, in the upper 6 inches of this soil. Ten samples taken from the centers of squares formed by the original trees contained an average of 9.2 p.p.m.

Table 2.—Yields of prunes and sweet cherries planted on former apple orchard land at Parma.

Kind of fruit	Age of Trees	Mean yields in lb.		Odds of significance
		Trees in old tree holes	Trees between former tree rows	
Prunes	5 yr.	25.0 ± 5.7	67.0 ± 5.7	9999:1
Prunes	6 yr.	109.0 ± 7.0	173.0 ± 10.0	9999:1
Sweet Cherries	6 yr.	8.4 ± 2.2	15.7 ± 3.0	30:1

Removal of the old orchard caused considerable disturbance of the soil close to where the trees had stood. As large roots were pulled out subsoil became mixed with surface soil. Air pockets and large lumps of compact soil remained even after plowing, discing, and levelling. This physical condition of the soil probably contributed to the poor growth of trees planted in the old tree holes. The poor growth of these trees also might be due in part to the effect of the original trees on soil fertility. Each of these would tend to impoverish the soil most severely close to where the tree stood, as it is there that roots would have been present for the longest time. Moreover, according to Beckenbach and Gourley *(1)*, the greatest concentration of roots in apple trees, per unit volume of soil, is to be found close to the trunk.

Experiments with Small Fruits

Small fruits planted immediately after removal of the old apple orchard in 1936 included Latham and Newburgh red raspberries; Cumberland black raspberries; Youngberries; Eldorado blackberries; Worden, Niagara, and Concord grapes; and Gem, Blakemore, Dorsett, Fairfax, and Howard 17 strawberries. Some mortality was experienced in establishing these plants, especially the strawberries. This undoubtedly was due in part to a lack of water for irrigation for a week or more after planting, but residual effects of the old orchard also certainly played a part in their failure to survive. In all cases mortality after transplanting was higher, and subsequent growth of plants that survived was poorer, in and near former tree positions than between former tree rows. Grapes, blackberries, and dewberries made reasonably good growth and appeared normal when planted between the old tree rows while red and black raspberries were noticeably stunted the first year but seemed to recover and make normal growth the second year. Results with strawberries were inconclusive. The mortality rate was high during the first half of the growing season, but this was due in part, at least, to inadequate irrigation and damage by white grubs. Plants that survived were vigorous, made good growth in the latter part of the season, and appeared normal the second year.

The small fruit plantings were expanded greatly in the spring of 1937, one year after removal of the old orchard. The new plantings were established on soil that had been summer fallowed throughout the previous year in an effort to destroy weeds and to level the land. A large variety of red, black, and purple cane raspberries, blackberries, dewberries, and grapes were included in this planting, and all made good growth except close to old tree holes where, in most instances, the plants were visibly but not seriously stunted. The following year all of these plants were nearly normal in appearance and have since been highly productive. Strawberries planted the second year responded much like the first-year planting. Many plants died early in the growing season but those that survived made good growth, especially in their second year.

Experiments with Vegetables

First experiments with vegetables were made in 1936. Seed of the early planted crops was planted within a month following removal of the old apple trees. These included onions, carrots, sweet corn, radishes, and orach.

As a result of this season's work rather definite statements can be made: (1) Satisfactory yields of none of these crops can be obtained when planting is made so soon following removal of apple trees; (2) Carrots were more satisfactory than onions in following apple trees; and (3) While the stand of onions was poor, better stands with a resulting increase in yields were obtained from those rows which were distant from the tree locations.

Fifteen rows of sweet corn were so planted that the middle row was practically superimposed on an old tree row. Rows were 3 feet apart and the hills 3 feet apart in the rows. After the corn had reached the tasseling stage, the locations of the old trees were very apparent from the difference in growth. From the low hills of not more than a few inches in height in the immediate proximity of the old trees, the plants increased to heights approaching 6 feet at mid-points between the former tree rows. A composite diagram of the field, showing the mean heights of cross rows numbering from 1 to 80, is shown in Figure 2. It will be noted that in almost every instance, the lowest points on the line correspond with the rows intersecting or crossing the old tree hole. Furthermore, greatest heights are practically mid-way between tree rows. Records other than height were not taken. Field observations, however, indicate that yield records would correlate rather definitely with height of plants.

Fairly good stands were obtained in the radish and orach plantings. Plants were vigorous, and, for the most part, were not as severely affected as were carrots, onions, and sweet corn. As neither of these is an important crop, it is hardly worth while to more than mention them, although growing radishes for seed purposes might be a possibility.

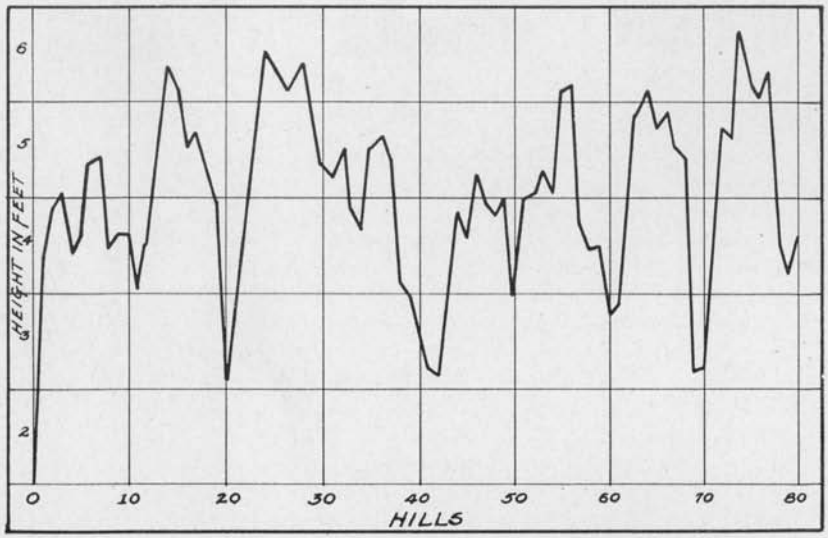
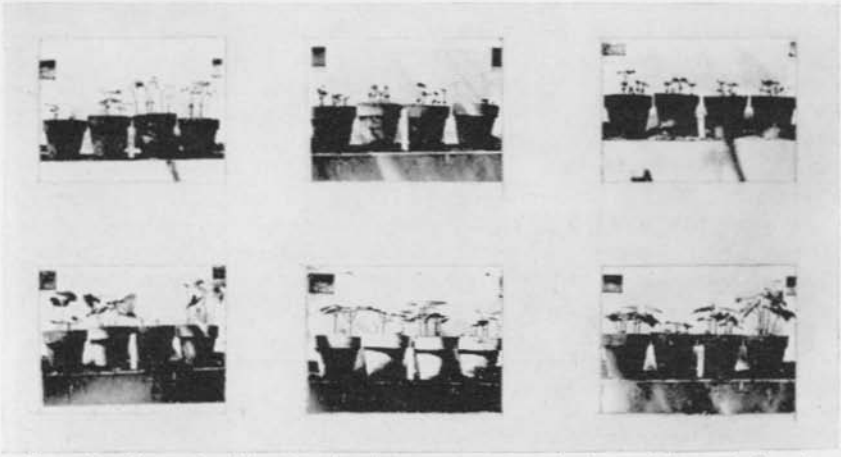


Figure 2.—Average height of 15 rows of corn, the middle row of which was superimposed upon the location of an old tree row. The vertical lines show the locations of the old trees in relation to the length of the planting.

In 1937, soil samples were taken from (a) old tree locations and (b) points mid-way between points where trees previously had been. Both soils were supplemented with organic material, such as sheep manure, peat moss, and straw, and inorganic commercial fertilizers. These mixtures then were used in pot cultures in the greenhouse. Pencil Pod Black Wax beans were grown in them as indicators. Figure 3 shows growth of beans on some of the treatments used. Where ammonium sulphate was used at the rate of 200 pounds per acre, growth was greater on soil from the old tree holes than on the soil distant from them. That this situation would be repeated in subsequent experiments is doubtful, for in all other treatments, growth was superior in bean plants grown on the soil from between the old trees. It may be seen also from the figure that these differences between plants grown on the two soils were rather marked.



Figue 3.—Beans in old orchard soils: upper row, soils from old tree holes; lower row, soil from between tree rows. Left to right: check-no treatment; sheep manure at rate of 20 tons per acre; sheep manure at rate of 40 tons per acre.

While no experiments were conducted with vegetables subsequent to 1937, a few observations have been made. For example, one field of carrots, planted in July on land just reclaimed from an old orchard, showed very little ill effects. Although it was possible to pick out the locations of the old tree holes, the areas affected were very small. Potatoes, when planted on land following old orchards, showed no influence of the previous tree plantings. This is in agreement with the observations made by Vincent *(7)*.

There are good indications that some of the vine crops, notably watermelons and muskmelons, are not affected noticeably for having followed apple trees. Both of these crops were included in the program during 1936 and 1937. Vine growth was normal, yields were good, and the quality of the fruits was satisfactory. Disease is a factor in production of these crops in this section and should be considered in laying out a vegetable program.

Since 1936, the year in which the Parma land was reclaimed from old orchard, regular and heavy applications of barnyard manure have been made. Approximately half of the original orchard has been used for vegetable and vegetable seed crops. First of these crops to be planted was lettuce, which was seeded during the first week of August 1936. Manure, at the rate of 10 tons per acre, had been applied to one-half of the land during April 1936. In making plantings, the old tree locations were avoided. For the most part, these plantings were successful. Leaf lettuce and cos lettuce were especially good. Generally speaking, the greatest difficulty to be encountered in a practice of this sort is in preparation of a suitable seedbed for the crop. This is true even where manure has been used if plantings are to be made so soon after tree removal.

In addition to these crops, grown more or less for truck purposes, vegetable seed crops were grown for harvest during the summer of 1938. These included carrots, rutabagas (involving parts of both 1937 and 1938) and radishes. As previously noted, seed stock of carrots grown during the latter part of 1937 showed very slight ill effects for having followed the apple trees. Figures 4 and 5 show radish and rutabaga grown for seed. While rutabaga planting was not extensive, the yield was exceptionally heavy—approximately 3,000 pounds per acre. Several rows of radish seed were included in the planting and here the seed yield was in excess of the average for commercial seed fields. Manure was applied to this land in 1936 at the rate of 15 tons per acre.

Figure 4.—Radish planting for seed. Parma Branch Experiment Station, 1938.

This same area was used for lettuce trials again in 1939 and 1940. In the meantime more manure had been added. It can be seen from Figure 6 that a very uniform and satisfactory crop was obtained in 1940, four years after the apple trees had been removed. The condition was practically the same in 1939.

In addition to the lettuce plantings noted above seed crops of turnips, onions, carrots, and other miscellaneous vegetables have been grown without making any effort to avoid old tree locations. In all cases, barnyard manure has been liberally applied. No deleterious results have been encountered in attempts made to grow these crops during the past three or four seasons.

Experiments with Cover Crops

The experience of most apple growers in Idaho has shown that a program of cover cropping for a period of 1 to 3 years is the most helpful and

Figure 5.—Turnip seed on old orchard land. Parma Branch Experiment Station, 1938.

economical means of renovating old apple orchard land. Cover crops grown experimentally on old orchard land at the Parma Branch Station include winter rye, Sudan grass, Kentucky bluegrass, alfalfa, annual and biennial sweet clovers, winter vetch, soybeans, and Austrian winter peas.

Figure 6.—Head lettuce variety trial, Parma Branch Station, 1940.

All of these crops except Austrian winter peas were planted in a mature apple orchard 2 years before the trees were removed. These crops were affected by dense shade and tree competition as well as by arsenical residues in the soil. Under these conditions Sudan grass was the only crop that made satisfactory growth *(See Figure 7)*. Growth of this crop has been good both under the shade and competition of a mature orchard and on land newly cleared of orchard. Rye, sown either as a fall or spring crop shortly after removal of trees, also has proved satisfactory.

Figure 7.—Sudan grass growing in mature apple orchard at Parma. The soil between the tree rows had an average arsenic content of 9.2 p.p.m. as As_2O_3 in the surface 6 inches. Sudan grass is an excellent cover crop for reclaiming arsenic-contaminated soils after apple trees have been removed.

All of these cover crops when planted after the trees had been removed have shown a decidedly poorer stand of plants and weaker growth in the vicinity of old tree holes than in the areas between former tree rows *(See cover illustration)*. The nonlegumes have in all cases been superior to the legumes when planted shortly after tree removal. A high mortality of seedlings seems to be the greatest obstacle in establishing the legumes. With the exception of soybeans and Austrian winter peas, legume plants that survived long enough to develop a root system sufficient to extend below the zone of highest concentration of arsenic (about the upper 6 inches of soil) usually made good growth.

The longer the land had been cleared the better the growth of all cover crops. Excellent growth was obtained with vetch, alfalfa, and annual and biennial sweet clovers planted 4 years and 5 years after the trees were removed at Parma. By the time legumes will make good growth, however, other crops will do likewise and further cover cropping to rebuild the soil is not necessary.

Recommendations to Growers

When large trees are uprooted in the process of removing a mature orchard the soil is left in very bad condition. The ground is uneven, there

are large holes where the trees stood, and tree roots, old alfalfa crowns and debris from weeds and cover crops interfere with plowing and fitting of the soil. Before a satisfactory seed bed can be prepared for planting row crops it usually is necessary that the soil be worked several times, with an opportunity to settle between operations. Row crops, therefore, as shown in these experiments, are not likely to be satisfactory or profitable the first year, especially if the orchard is not removed until shortly before spring farming operations begin. Tree fruits might be established with some degree of success the first year by avoiding the old tree holes in planting, and some small fruits might prove fairly satisfactory. Usually, however, the best procedure is to devote at least the first year to improving the condition of the soil by the necessary plowing, discing, and levelling operations, and by destroying weeds and building up the soil organic matter.

The following practices are recommended for bringing these old orchard lands back to profitable production.

Planting Cover Crops

As soon as possible after the trees have been pulled, plow the land, remove as many tree roots as possible, and harrow and float the land in several different directions in order to level it. If the trees are removed shortly after harvest the soil has an opportunity to settle over winter, making a firmer seed bed before spring planting. If the soil can be prepared for early spring planting, rye should be sown at a rate of 90 pounds per acre. This should be plowed under or disced when the heads begin to form, and should be followed by Sudan grass sown at a rate of 25 pounds per acre as soon as a suitable seedbed can be established. Sudan grass may be planted as late as the middle of July, but earlier planting is to be preferred. This crop is turned under in early fall, preferably before frost, the ground again is fitted for seeding and planted with winter rye. The rye should be worked into the soil early the following spring, or not later than the time heads begin to form.

Should the land not be in suitable condition for the first seeding of a cover crop until late spring, Sudan grass should be sown first rather than rye. This crop may be planted any time after danger of frost is past. Winter rye should follow in early autumn as recommended above.

It is recognized that the seeding of two or three cover crops in a year is a costly program, but it must be remembered that any program for refitting these soils necessarily will be expensive. There is evidence that these soils can be reclaimed simply by letting volunteer weeds grow for 5 or 6 years. This involves but little expense, but neither does any profit accrue from the use of the land. The most economical program is one that will return the land to profitable production in a reasonably short time.

There are a few instances on record where it has seemed profitable to modify the cover cropping system recommended above by permitting either the rye or the Sudan grass to mature, and harvesting a crop of seed. The ripened straw, which should be returned to the soil, does not break down so readily as the more succulent, immature plants. The rate of decompo-

sition of the straw can be increased by the addition of manure or other nitrogenous fertilizer. Whether or not seed should be harvested from any of the cover crops depends on a number of factors. If the crops are making good growth, indicating that the toxic condition of the soil is not very severe, and if there is a ready market and good price for the seed, harvesting the crop may be justified. The main objective of reclaiming the soil as quickly as possible should not be lost from sight, however.

Liberal applications of barnyard manure, (20 to 30 tons per acre), both in conjunction with the cover cropping and after cash crops again are planted, will aid materially in bringing these soils back to profitable production. The number of years that should be devoted to cover crops will depend upon the amount of arsenical residue in the soil, the amount of manure available for supplementing the cover crops, and the kinds of crops ultimately to be grown. If the cover crops are not seriously stunted the first year, it is possible to attain a profitable production of either potatoes or sugar beets the second year. So long as the growth of rye and Sudan grass is seriously depressed other crops are unlikely to prove profitable. In such a case cover cropping should be continued for another year or two.

Planting Tree Fruits

Tree fruits should not be planted until at least 1 year after the removal of an apple orchard. A longer interval, up to 3 or 4 years, may be desirable if the toxic condition of the soil, as indicated by cover crop growth, is very severe. Some fruits, as apricots, might be set safely the first spring after tree removal if they can be planted between former tree rows, but this seldom is possible due to the difference in spacing of apples and other fruits. Some trees necessarily would be set in or very close to old tree holes. Before the orchard is pulled semi-permanent stakes should be driven along the four sides to mark the tree rows so that former tree positions can be located when new trees are planted. If the new orchard is to have the same spacing as the old one all the new trees can be planted in the centers of squares formed by trees in the original planting. If the spacing is to be greater or less than before, some of the new trees necessarily must be set in or very near former tree positions.

By having these former tree positions marked with stakes, special treatment may be given the trees planted in or near them. The holes where such trees are planted should be filled with soil hauled in from a nearby field where fruit trees have not been grown previously. A liberal top dressing of barnyard manure, covering about a 3-foot radius around the tree, should be applied as soon as possible after planting. This is especially important for trees planted near old tree holes, and is desirable for all of the trees if a sufficient supply of manure is available.

A question may be raised as to the advisability of replanting apple trees on old apple land, as this would result in further building up of arsenic on soil already heavily contaminated. No observations of the long-time effects of such a practice have been possible.

Planting Small Fruits

Small fruits, like tree fruits, should not be planted on old apple land for at least a year after the trees are removed, and a longer delay is desir-

able. In addition to a program of cover cropping such as outlined above, liberal applications of manure (20 to 30 tons per acre) should precede the planting of small fruits. Grapes, blackberries, dewberries, and raspberries probably can be established sooner and more easily than strawberries. Careful attention should be given to irrigation until the plants are well established. Much of their new root growth in the first few weeks after transplanting must be made in the upper layers of soil where the arsenical residues are the greatest. If the plants are brought successfully through this early period they will be able to extend their roots into deeper soil where the toxic condition is less severe.

Planting Vegetables

1. The system of cover-cropping already outlined may well be used before inaugurating any sort of a vegetable program. While residual effects of spray materials may not be exhibited in some of the vegetable crops, it nevertheless is evident that the physical nature of the orchard land is not conducive to good cultural practices. Seeding is difficult, irrigation cannot be as even as could be desired, nor may cultivation and weeding proceed to the best advantage for the crop grown.

2. Where manure is available in quantity, its use is strongly encouraged. Its application, as recommended for cover crops will be of benefit to a subsequent crop of vegetables. If the cover crop program must be discontinued, annual applications of from 10 to 15 tons of manure will be of benefit. It should be pointed out, at the same time, that large amounts of organic residue in an undecomposed condition will bring about an actual nitrogen deficiency. This may be corrected by either waiting until the organic matter is decomposed or by adding some form of an inorganic nitrogenous fertilizer.

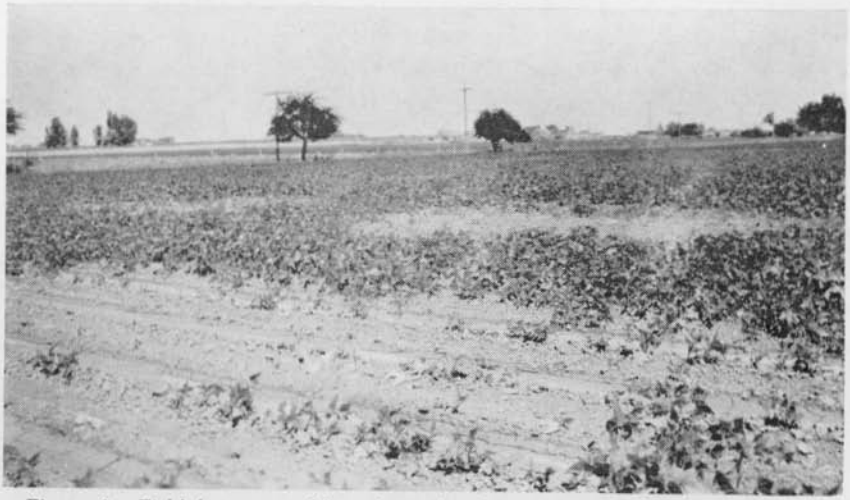


Figure 8.—Field beans on old apple orchard land near Twin Falls. Bare area in center marks former tree location. Orchard removed 4 years previously.

3. If it is necessary to use abandoned orchard land for vegetable production, an effort should be made to select crops best adapted to the condition. Potatoes, carrots, rutabagas, and probably other root crops such as radishes and turnips are among those best suited to follow an old orchard. There are likewise good possibilities for production of seed crops of onions, carrots and certain other root vegetables. If onion seed is to be grown, it is better to obtain the bulbs from an outside source. It has been shown from the cover crop studies that legumes do not establish themselves satisfactorily on this land. The same is true of the legume vegetables, beans and peas not being suitable for use following apple trees.

4. Finally, it should be borne in mind that time plays an important part in the adaptability of old orchard land to agricultural uses. Some system of fallowing, or the use of row crops which are tolerant to conditions following tree removal may be means of bringing the land back into satisfactory use for most vegetable crops.

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