THE EFFECT OF WATER SOLUBLE EXTRACTS FROM PEACH PARTS ON BIOASSAYS OF TOMATO AND THE EFFECT OF PEACH ROOT SOIL AMENDMENTS AND LIME ON GROWTH OF PEACH SEEDLINGS

By

NASRIN SADRIAN

Bachelor of Science in Agriculture

Pahlavi University

Shiraz, Iran

1974

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
December, 1977

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Thesis Approved:

Herman A. Hinrichs
Thesis Adviser

Ronald W. McNew

[illegible]

W R Kays

Norman N Durham
Dean of the Graduate College

ACKNOWLEDGMENTS

The author wishes to express her appreciation and sincere gratitude to Professor Herman Hinrichs, my adviser, for his assistance, interest, and encouragement throughout the course of this study.

Appreciation is expressed to Dr. Grant Vest, Head of the Horticulture Department, for his assistance in the preparation of this manuscript.

Additional gratitude is extended to Dr. Ronald McNew for his extensive assistance with this study and Professor W. R. Kays for his invaluable guidance in this study and preparation of the manuscript.

Special thanks and appreciation are extended to Mrs. Joyce A. Aldrege for her assistance, Mrs. B. T. Motamani, and Mr. H. Mojtahedi for their patience and understanding during the entire course of my graduate work.

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CHAPTER I

INTRODUCTION

Peach tree Prunus persica (L.) decline is a common problem among young trees planted in old peach sites. Although decline has been reported on other fruit trees, the replant of peach trees in old peach orchards appears to be the most serious problem (4) (23). The death and poor growth of trees suffering from peach short-life is reaching epidemic proportions in Georgia and other areas of the southeastern United States (6) (12) (29). Even some peach growers in Oklahoma have reported this problem. Peach tree short-life is a world-wide problem; however, it is more severe in some areas than in others, suggesting that environmental factors also may be involved (14).

Many researchers feel this problem is caused by a disease complex rather than a single causal agent (18) (4) (5). Several causal factors have been suggested, such as the deterioration of the soil structure, an unfavorable microbial population in the soil, a nutritional deficiency, a nutritional imbalance, a build-up of soil nematodes, an accumulation of toxic substances in the soil, and some other minor factors such as time of pruning (3) (5) (11) (22) (24).

In many cases the symptoms of the disease have been worse on the trees planted directly into the old tree sites. Trees planted between the old sites showed less damage (3) (4) (26). Peach decline has also been reported to be more severe when the trees are planted in the orchard only shortly after the former trees were removed; but if a longer period of time elapses before replanting, the trees are less subject to short-life (14). It has been observed that besides the usual chemical constituents found in any wood roots, peach roots contain a cyanide containing compound, amygdalin (7) (27). Decomposition of roots which causes release of cyanide may be involved in the replant problem (11) (16) (20). The enzyme B-glucosidase, which is present either in root tissue or can be produced by specific microorganisms, is responsible for the breakdown of the amygdalin in peach roots (16) (21).

The use of sulfur over many years has caused the pH of the soil in many orchards to become very low. This acid condition is especially severe in the southeastern United States where peach replant disease is prevalent (28). The increase in aluminum ion availability and the decrease in the availability of other essential ions such as calcium, magnesium, and phosphorus, may be part of the short-life problem (8) (28). Liming has been used to increase the soil pH and the calcium content of the soil (25) (28) (29).

The purpose of this study was to determine if the peach short-life is due to the presence of toxic materials in the soil resulting from decomposition of old peach roots and other peach plant parts as well as to determine whether liming can be used to control the problem of growing new peach trees in old peach orchards.

CHAPTER II

LITERATURE REVIEW

The replanting of peach trees in old peach sites has in many cases caused young trees either to die or fail to grow properly (17) (12) (15). Peach tree short-life has been a problem for peach growers for more than 100 years (15). Although many theories have been suggested, the exact causal agent is unknown and there is no known method of control (23). The presence of toxic materials in the soil, which resulted from the decomposition of old peach roots, has been suggested by Ward and Durkee as a cause of decline (27).

In many experiments it was found that peach seedlings were stunted and often died when they were grown in soil containing old peach roots (2) (21) (26). This was also true of the plum, cherry, apricot, and myrobalan plum trees planted in soil containing old peach roots (26). One possible reason is that peach roots contain amygdalin which, when decomposed, is broken down into glucose, benzaldehyde and hydrogen cyanide (7) (16) (27). While determining the respiration rate of excised peach root tips, Patrick (18) found that the extract from peach roots and chemically pure amygdalin had a toxic effect on the tissue, but only when the enzyme B-glucosidase was present. In addition to inhibiting respiration, these substances induced darkening and finally the necrosis of meristematic cells. Both cyanide and benzaldehyde is readily oxidized and some converted to benzoic acid. The toxic effect of amygdalin is probably due to the hydrogen cyanide (7) (16).

Cyanide is water soluble and will readily leach from the soil. This might explain the finding by Mountain and Boyce (13) that increasing the time interval between the removal of the old trees and the planting of the new trees had a beneficial effect on the newly-set trees.

The enzyme B-glucosidase, which acts on the amygdalin, is present in the living root tissue but is separated from the amygdalin (16). When the cells of these roots are attacked by any lesion-producing agents, such as nematodes, fungus, or insects, or when the roots begin to decompose naturally after the tree has been removed, the enzymes and amygdalin are brought together and cyanide is released (14) (16).

Another source of the B-glucosidase is from certain soil microorganisms which utilize amygdalin as a nutrient. These microorganisms are found in areas where glycoside acculualtes, and tend to build up in the area as long as the raw material, amygdalin, is available (16). As evidence for the role of these microorganisms in the breakdown of amygdalin, Patrick (16) measured the amount of cyanide released from synthetic amygdalin and from the bark of peach roots. They were placed in soil collected from three different locations: the site of the old peach tree, from the area between the old peach trees, and from an area adjacent to the peach orchard but not in peaches. The soil from all three locations was screened so that old peach roots would not be an additional source of B-glucosidase for the synthetic amygdalin test. He found that soil from the old tree site contained the greatest amount of cyanide when both the root and the synthetic amygdalin were used. These results indicate that the old roots contain amygdalin and that there is a build-up of microorganisms in the old peach site. The

B-glucosidase produced by the microorganisms was responsible for the breakdown of the synthetic amygdalin.

In many experiments it was found that the amygdalin content in different plant parts of peach and apple varied significantly. Peach tissues were higher in amygdalin than apple and the seeds of peaches had more than either the leaves, shoots, or roots (7) (27). The higher amygdalin content in the seed was in the kernel while the stony pericarp had less (7). Do Oh and Carlson (7) prepared water suspensions from stony pericarp, kernel, root, and shoot of peach to treat peach, apple, and bean seedlings. They found that the water suspension from kernel significantly reduced the growth of the seedlings. The root and shoot suspensions were less effective.

It is believed that almost all of the amygdalin of root is present in the bark (21) (27). It was found by Patrick (16) that 0.5 grams of root residue of Lovell peach seedlings in a soil suspension will decrease the respiration rate of the peach root tip, in the same amount as would 0.25 grams of chemical amygdalin. It appears that relatively large amounts of amygdalin (as much as 50 mgm, per gram of root tissue) is present in Lovell peach roots and that as much as 5% of dry weight of peach root bark may be in the form of this glucoside or its components (7) (16).

Proebsting (21) observed that the decomposition of the roots of cherry, apricot, and myrobalan plum will produce the same toxic material but in a relatively smaller amount than the peach roots. In his experiment peach seedlings which were grown in a mixture of ground up roots of these trees showed reduced growth. However, he had found that when peaches were planted in old apple tree sites, the peach trees showed much better growth than peach trees planted in an adjacent block which had formerly been a peach orchard (20).

High acidity was reported in soil of old peach orchards (19) (28) (29) and hence some elements such as calcium magnesium, and phosphorous were less available. This may cause peach tree decline in old peach sites (11) (28). The toxicity of acid soil is due either to soluble aluminum or acid radicals (1) (9) (25). Soluble aluminum reduces overall permeability of the roots and also results in coagulation of protein (9); it may also compete with calcium and magnesium absorption by the roots (8) (25). Phosphorus in highly acid soil conditions will be precipitated by aluminum either in the soil or within the plant (11) (30). Phosphorus is present in higher percentages in the plants growing in acid soil compared to plants growing in neutral soil. This indicates that some phosphorus is not being used in the necessary metabolic processes (30).

Prince (19) reported that applying lime to the soil of old peach orchards increased pH and increased availability of phosphorus, calcium and magnesium. This resulted in better growth of newly planted peach trees.

Since the high amount of calcium oxylate crystals is present in the leaves from declining peach trees, Gallaher, Perkins, and Jones (10) believed that oxygen should be less available in these plants. More calcium is needed for neutralizing oxalic acid, which is produced, because of poor oxygen supply during the incomplete oxidation of carbohydrate or protein. Therefore, adding lime not only reduces the soil acidity but adds calcium to the soil (19) (28).

Soils that have a high calcium content have a lower nematode population than the soils that are acid (28). Nematodes damage by creating infection courts for certain bacteria and fungi in the peach soil to attack the roots and by affording opportunities for production of toxic material through the breakdown of amygdalin within the roots (14). Weaver and Wehunt (28) reported that applying 12 pounds of hydrated lime per tree to soil in old peach sites raised the pH from 1.76 to 6.0 and greatly decreased the population of nematode Criconomoides xenophox. This nematode is closely associated with susceptibility of peach trees to short-life (15).

CHAPTER III

MATERIALS AND METHODS

Tomato Seed Bioassay

The purpose of the bioassay tests was to determine whether there was toxic material present in peach tree parts and to compare their toxic content by determining the degree to which the leachates from those parts would affect germination of tomato seeds. Peach trees bearing fruit were used for preparing water soluble extracts for germination tests. Samples of roots, stems, and trunk tissue were also taken from a dying tree in the Ernest Fischer orchard near Porter, Oklahoma (Figure 1). Also, samples of decaying roots were obtained from soil where the peach tree tops had been removed for two years. Samples of leaves, stony pericarps and seeds were taken from healthy trees growing in the experiment station orchard at the Perkins Research Farm.

The plant parts were dried at room temperature and then ground by means of a Wiley Mill using a No. 20 mesh screen. The stony pericarps were crushed with a hammer while the kernels were cut into small pieces. A 50 gram sample of dried plant material was added to 400 ml of distilled water. After 24 hours the preparation was filtered using Frit-Fold Coarse Qualitative Filter Paper (14 cm). The kernel pieces were placed in distilled water and mixed with a Waring blender. The extracts were stored at 1.7°C until used in bioassay tests. Fifty seeds of Nemared tomato were placed on top of Sargent No. 500 filter paper in

Figure 1. Five-Year-Old Peach Tree Dying, Planted in Previous Peach Sites

each petre dish. The dishes were then placed on germinator trays according to randomized block design and each moistened with 3.5 cc of the extract. Additional solution of the extracts was added as needed to prevent the seeds from drying out. The germinator was operated at 20°C with 12 hours light per day under high humidity. There were nine treatments replicated two times in each of five blocks. The treatments consisted of extracts from the following parts: leaves, stony pericarps, and kernels from healthy trees; roots over 20 mm in diameter, roots under 20 mm in diameter; and trunk from a dying tree and decaying peach roots under 20 mm and over 20 mm in diameter. The control was distilled water. The test was started November 30, 1976. Germination data of the seeds were taken every two days and recorded.

The bioassay test was repeated February 14, 1977 with the same extracts except that from the small roots. The data analysis was accomplished by means of the LSD test and graphs were prepared based on the percent total or cumulative germination per treatment.

Soil Amendments of Shredded Trunk and Root Peach Plant Parts

In old peach orchard soils, especially in old site areas, there would be an abundance of roots left in the soil. Therefore, it is important to find out if the trunk and roots contain toxic material when they decompose. To determine the retardation of growth of peach seedlings three different experiments were conducted. Peach seeds were collected from the trees in the Perkins orchard. The seeds were stratified in moist peat at 1.7°C for 90 days. The roots and trunk were shredded into small pieces and mixed with various amounts of peat and perlite.

The first experiment was started on December 30, 1976. Five stratified seeds were planted in one gallon plastic containers in soil mixtures of 0%, 25%, 50%, 75%, and 100% shredded peach roots and trunk. Initially, there were five containers for each treatment. On January 5, 1977 each container was fertilized with 5 grams of Osmocot (18-6-12). The germination of peach seeds was very low. Since the plant stand was not uniform the tallest plant in each container was measured and recorded. Some containers in each treatment failed to have seeds to germinate. On April 16, 1977 the stem heights were measured. The seedlings were removed from the containers and the roots were washed with water. The roots and tops were weighed in each treatment.

To determine if the material was toxic two 50 gram samples of each of the 50% and 100% soil amendments where the seedlings were undergoing poor growth were mixed with 200 and 400 ml of distilled water. These four solutions were left for 24 hours and then filtered. The bioassay test with tomato seed was started April 20, 1977, using a completely randomized design with five treatments replicated twice in each of three blocks. There were 50 seeds in each petre dish. The petre dishes were not placed in the germinator but held at room temperature (20°C).

On January 8, 1977 the stratified peach seeds were planted in a flat containing peat moss and perlite. On January 24, 1977 one seedling was transplanted into a quart-size cheese carton using the same mixture of shredded roots and trunk as the previous experiment. There were five treatments arranged in a Latin square. The soil mixture was not fertilized but watered as needed. The stem diameters, tree height, root weight, top weight, and total weight of the seedlings were measured and recorded April 10, 1977. Following this experiment a tomato seed bioassay was conducted using the medium from the containers with 50% and 100% shredded material.

One-year-old peach seedlings 45 to 60 cm tall were planted in three-gallon plastic containers containing 0%, 10%, 20%, 30%, 40%, and 50% shredded trunk and root parts in peat and perlite mixture. The trees were pruned to about 45 cm in height and placed on a bench in the greenhouse on February 11, 1977. The treatments were randomized. Liquid fertilizer (20-20-20), 500 ppm, was applied March 20, April 11, and April 28, 1977. The length of new stem growth, the weight of the tops and of the roots were measured May 14, 1977.

Lime Application

The purpose of this experiment was to determine if adding hydrated lime to the acid soil of an old orchard would increase the growth rate of peach seedlings. The soil was collected from an orchard that had been in peaches for the past 35 years at Perkins Experimental Farm. The soil test prior to planting the seedlings showed a pH reading of 4.3. One-year-old peach seedlings with the same height as in previous experiments were planted in soil in three-gallon plastic containers. The lateral branches of seedlings were removed and tops were cut back to a uniform height of about 45 cm. Treatments were unlimed, limed with 31.2 grams and limed with 62.5 grams per container. This was equivalent to adding 0, 2500, and 5000 kilograms of lime per hectare. The experiment was conducted in the greenhouse in a completely randomized block design with three treatments replicated twice in each of four blocks. The test was started on February 18, 1977. Liquid fertilizer (20-20-20), at a concentration percent of 500 ppm was applied March 20, April 11, and April 28, 1977. The pH was determined from the soil in each treatment April 14 and May 18, 1977. The length of new stem growth, the root weight, and top weight were measured on May 19, 1977.

CHAPTER IV

RESULTS AND DISCUSSION

Tomato Seed Bioassay

Tomato seed germination showed considerable variation to extracts of certain peach plant parts. The first bioassay test indicated that seeds treated with extracts from kernels, leaves and stems germinated significantly slower than the untreated seeds (Table I). It is apparent that the extract caused a delay rather than preventing germination. The leaf extracts had the greatest effect with the slowest and the lowest per cent of germination--37%. The kernel extract allowed a 78.6% germination while the stem extract resulted in 87.0% germination as compared to 95.6% germination for the control. The high amygdalin content of the kernel reported by Do Oh and Carlson (7) supported the finding for kernel extracts. Since the leaves contain less amygdalin than other peach plant parts as reported (7) (27), the inhibition of germination by leaf extract may be due to material other than cyanide.

Since it is reported (7) (27) that a high amount of amygdalin is present in the bark of roots and the root extracts were expected to reduce the comparative rate of germination, the bioassay test from the root extracts indicated there were no differences in germination on the thirteenth day, which was the final reading for germination. It should be noted that there were significant differences five and seven days after treatment for decaying roots under 20 mm and roots under 20 mm

TABLE I

THE EFFECT OF WATER-SOLUBLE EXTRACTS OF PEACH PARTS ON THE GERMINATION OF TOMATO SEEDS (FIRST BIOASSAY TEST)

	Mean Number of Seeds Germinated[1]				
	Days After Treatment				
Extracts	5	7	9	11	13
1. Decaying roots, over 20 mm in diameter	7.9 a[2]	43.2 a	47.3 a	47.6 a	48.0 a
2. Decaying roots, under 20 mm in diameter	3.1 b	36.0 b	45.2 ac	47.1 a	47.3 ab
3. Roots under 20 mm in diameter, dying tree	1.2 b	25.6 c	41.8 c	44.3 a	45.4 ab
4. Trunk, dying tree	2.7 b	24.1 c	43.1 bc	46.7 a	48.1 a
5. Stems, dying tree	0.1 b	1.5 de	14.8 d	31.1 b	43.5 b
6. Leaves, healthy trees	0.2 b	0.2 d	1.3 e	5.4 c	18.5 c
7. Stony pericarp, healthy tree	2.6 b	36.1 b	46.4 ab	47.5 a	48.1 a
8. Kernels, healthy trees	1.0 b	6.0 c	14.9 d	27.6 b	39.3 d
9. Control, distilled water	6.4 a	40.2 ab	46.1 ab	47.0 a	47.8 a

[1]Fifty seeds per replication; two replications per treatment in each of five blocks.

[2]Means in a column followed by the same letter are not different at the .05 level of significance using the least significant difference (LSD).

TABLE II

THE EFFECT OF WATER-SOLUBLE EXTRACTS OF PEACH PARTS ON THE GERMINATION OF TOMATO SEEDS (SECOND BIOASSAY TEST)

Extracts	Mean Number of Seeds Germinated[1]				
	Days After Treatment				
	5	7	9	11	13
1. Decaying roots, over 20 mm in diameter	24.9 a[2]	43.5 a	46.4 a	46.4 a	46.4 a
2. Trunk, dying tree	21.4 a	40.4 a	45.5 a	46.2 a	46.2 a
3. Stems, dying tree	0.4 d	3.0 cd	15.5 b	19.1 b	21.5 b
4. Leaves, healthy trees	0.0 d	0.1 d	2.2 e	5.9 d	9.5 c
5. Stony pericarps, healthy trees	14.9 c	34.7 b	43.7 a	44.2 a	44.7 a
6. Kernels, healthy trees	2.6 d	7.9 c	11.5 b	13.4 c	16.7 b
7. Control, distilled water	35.6 b	44.3 a	46.7 a	47.8 a	47.8 a

[1]Fifty seeds per replication; two replication per treatment in each of five blocks.

[2]Means in a column followed by the same letter are not different at the .05 level of significance using the LSD.

TABLE III

GROWTH OF PEACH SEEDLING WHEN GROWN FROM SEED IN VARIOUS SOIL AMENDMENTS CONTAINING SHREDDED TRUNK AND ROOT PARTS

Treatments	Number of Container	Average Growth of Peach Seedlings			
		Height (cm)	Root Wt. (g)	Top Wt. (g)	Total Wt.[1] (g)
1. 0% shredded trunk and root	3	72.77 ab	15.07 a	65.41 a	80.48 a[2]
2. 25% shredded trunk and root	4	86.83 a	13.10 a	44.34 b	57.44 ab
3. 50% shredded trunk and root	2	62.30 b	9.67 ab	22.07 c	31.23 bc
4. 75% shredded trunk and root	4	40.33 c	4.35 b	6.23 c	10.58 c
5. 100% shredded trunk and root	3	24.07 c	2.76 b	2.88 c	5.64 c

[1]All weights are fresh weights.

[2]Means in the same column followed by the same letter are not different at the .05 level of significance using the LSD.

from a dying tree. The data of these two treatments were not significant at thirteen days after treatment. The percent germination from the extracts of stems was significantly less than the control (Figure 2) and the leaves and kernels were significantly different from the roots (see Figure 3). There were no significant differences in the suppression of germination between extracts of trunk, stony pericarp and control.

The results of the second bioassay test was similar to the first. Even though there were significant differences between extracts of decaying roots over 20 mm in diameter, trunks and stony pericarp as compared to the controlled five and seven days following treatment, there were no significant differences more than seven days following treatment. The extracts of kernels, leaves, and stems differed significantly from the control. The cumulative percent germinated per treatment in this test is represented in Table II. Figures 4 and 5 show a marked difference in per cent germination from extracts of kernels, leaves, and stems when compared to germination of other plant part extracts.

Response of Soil Amendments on
Growth of Peach Seedlings

Although the results of the bioassay tests indicated that the extracts of roots and turnk had no effect on germination, the growth of peach seedlings in different soil mixtures with shredded root and trunk parts was significantly reduced. The average growth of peach seedlings when seeds are planted in various soil mixtures is shown in Table III. Tree height, root weight, top weight, and total weight decreased as the percent of peach soil increased. The only exception was in the average stem height at the 25% mixture, which was numerically greater than that

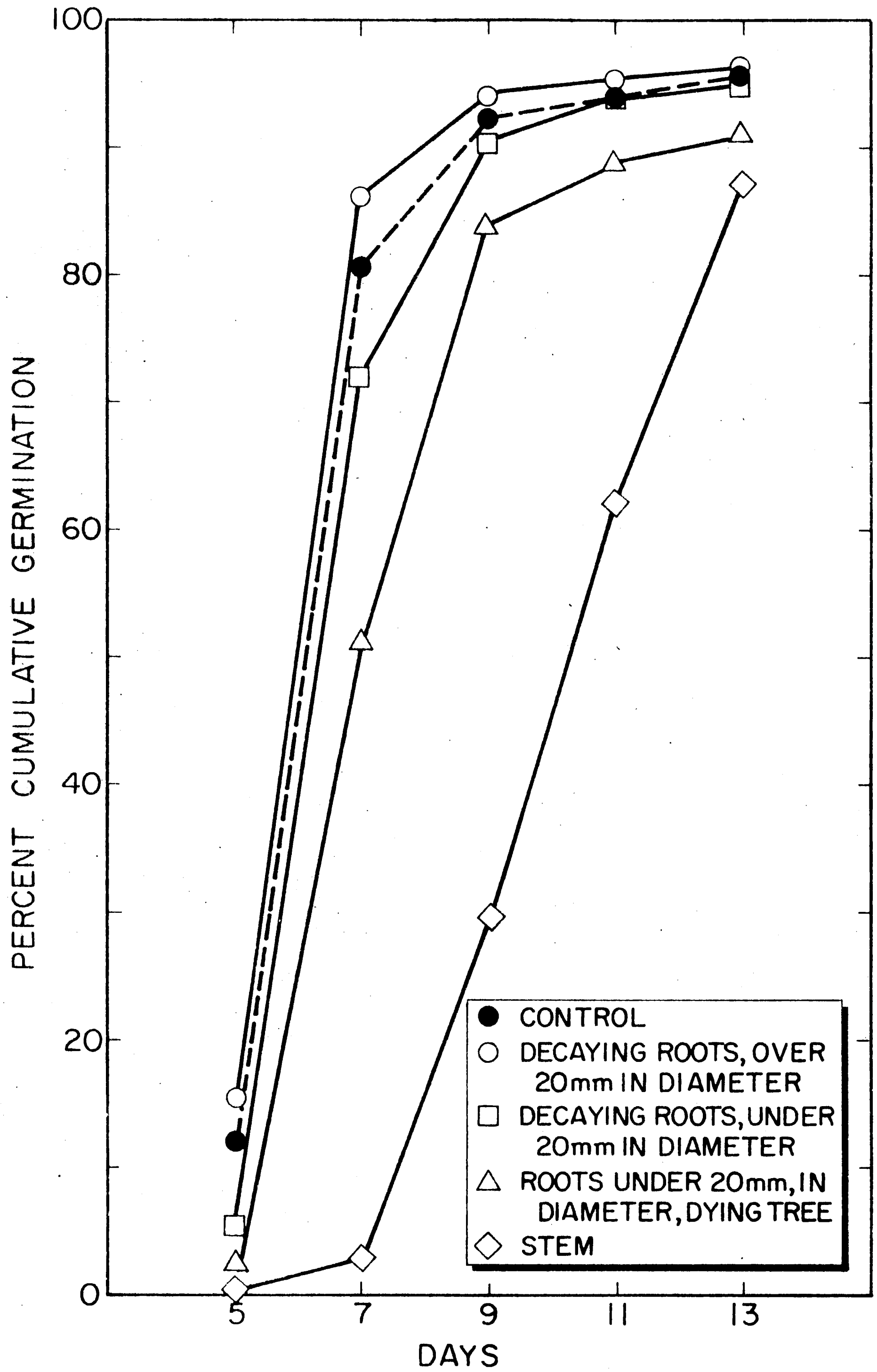

Figure 2. Effects of Water-Soluble Extracts from Decaying Roots over and under 20 mm in Diameter, Roots under 20 mm in Diameter from Dying Tree and Stems on Germination of Tomato Seed (First Bioassay Test)

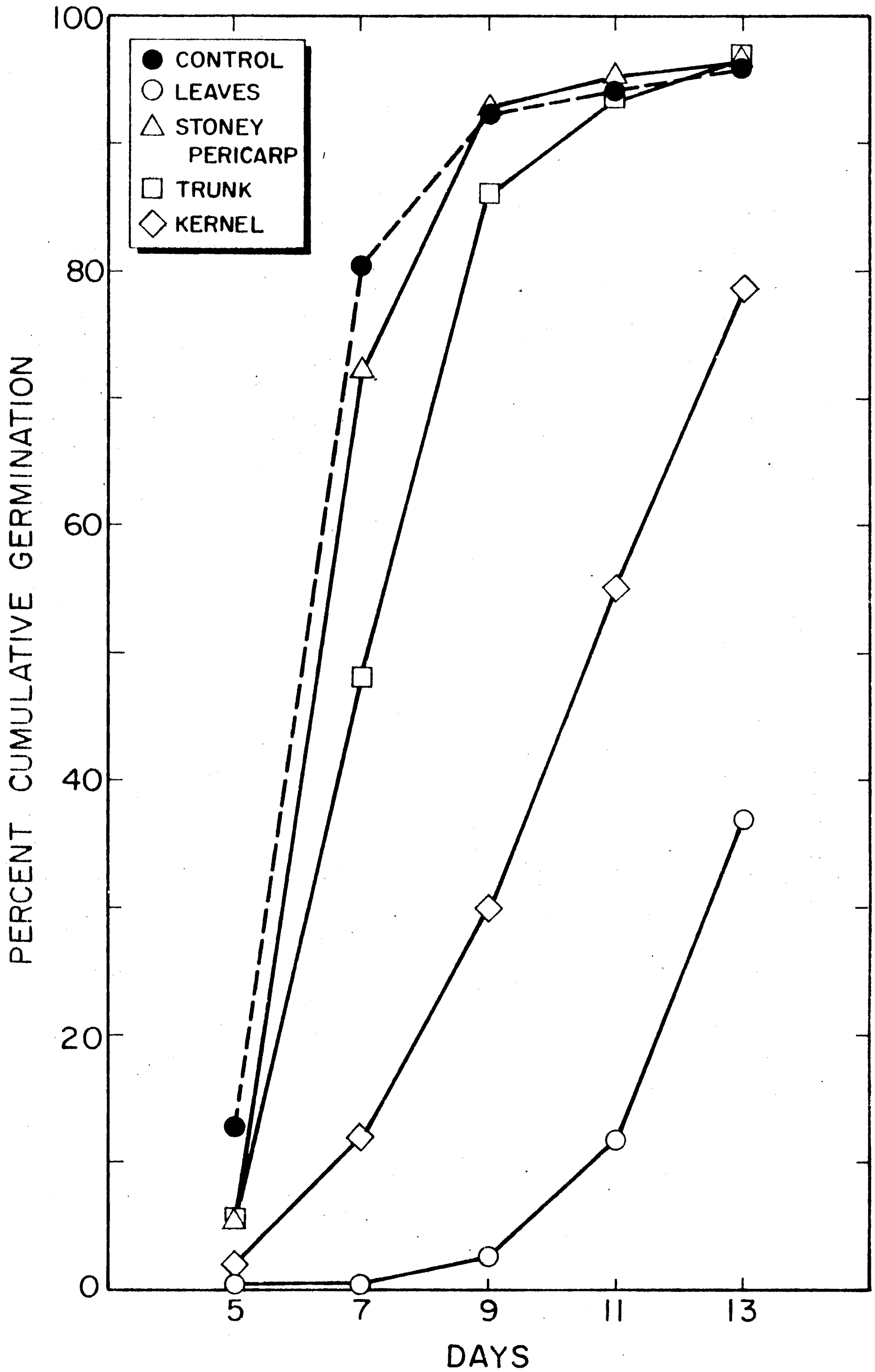

Figure 3. Effect of Water-Soluble Extracts from Stony Pericarps, Kernels, Leaves, and Trunk on Germination of Tomato Seed (First Bioassay Test)

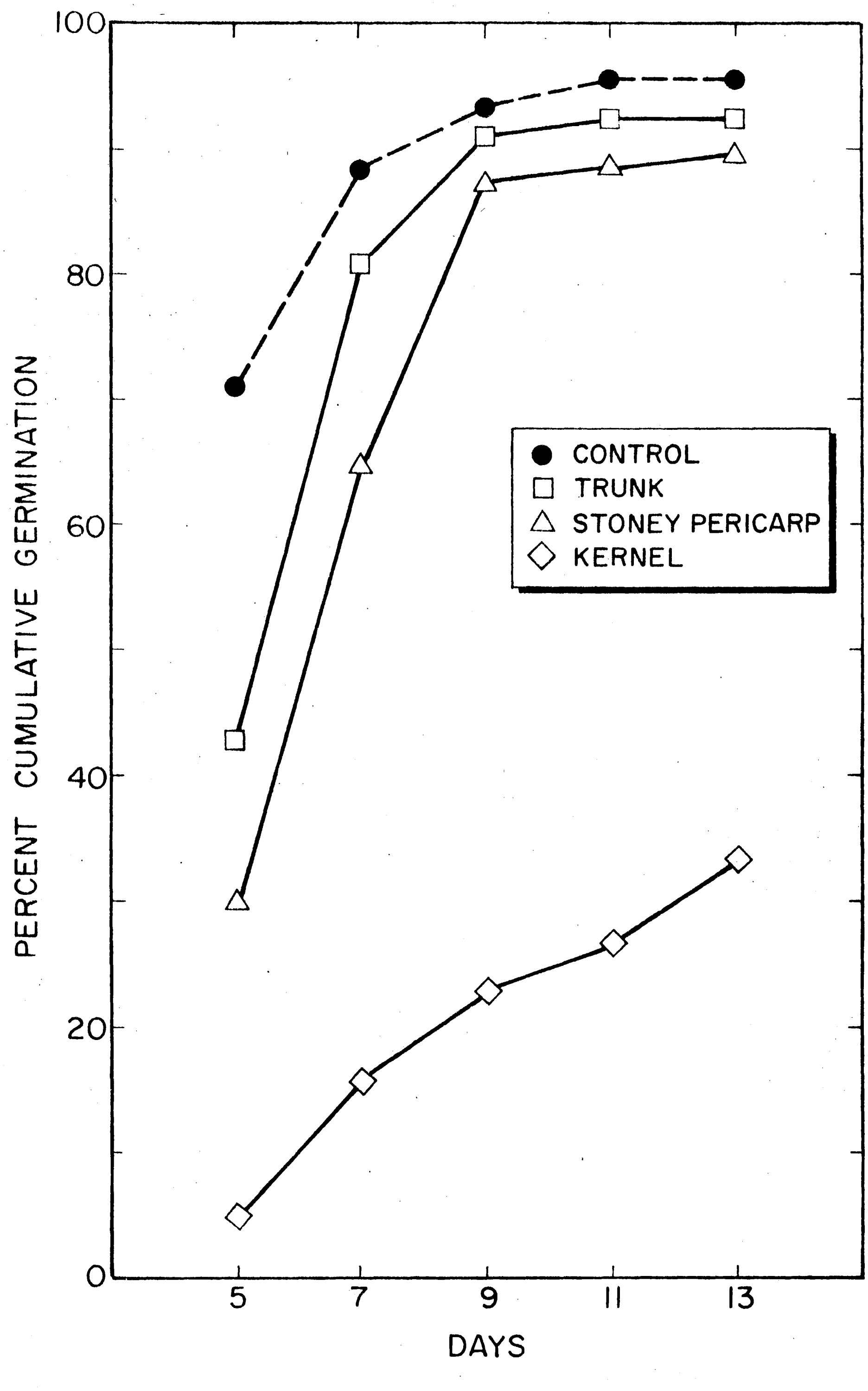

Figure 4. Effect of Water-Soluble Extracts from Stony Pericarps, Kernels, and Trunk on Germination of Tomato Seed (Second Bioassay Test)

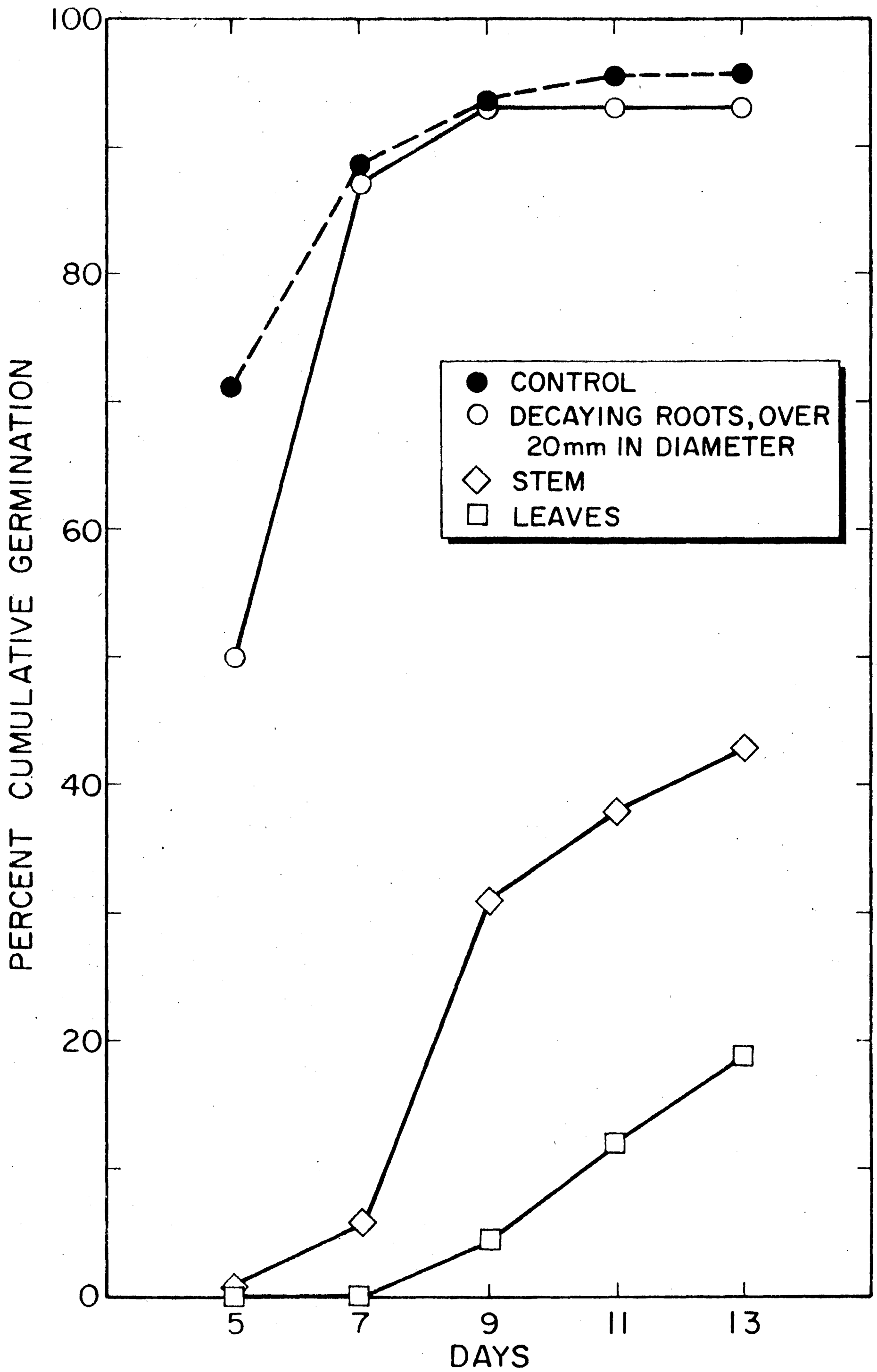

Figure 5. Effect of Water-Soluble Extracts from Decaying Roots over 20 mm in Diameter, Stems and Leaves on Germination of Tomato Seed (Second Bioassay Test)

in the 0% mixture (Figures 6 and 7).

There were no significant differences on tomato seed germination between extracts of either 50% or 100% mixtures when diluted with either 200 or 400 ml of distilled water (as shown in Table IV), but there was a significant difference between these and the control. This indicates that part of poor growth apparently was due to the toxicity rather than inadequate nutrition (see Figure 8).

The average growth of seedlings grown in different mixtures of shredded root and trunk in quart-size cartons is recorded in Table V. It is evident from Figures 9 and 10 that the reduction in growth was mostly proportionate to the amount of mixture added. The average height of seedlings in the 50% mixture was greater than in the 25% mixture, but it was not significant.

After the second seedling experiment, a tomato seed bioassay test was made from the 50% and 100% mixture. The results were quite similar to the previous tomato seed bioassay test (Table VI). From data given in Figure 11 it is evident that poor growth in the second seedling experiment also was related to the amount of toxic material present in the root and trunk.

An examination of Table VII shows that a significant reduction in growth occurred when one-year-old seedlings were grown in mixtures of shredded root and trunk. The amount of growth decreased as the amount of shredded turnk and root amendments was increased. The least amount of growth was obtained in the 50% mixture (Figures 12 and 13).

TABLE IV

THE EFFECT OF EXTRACTS FROM 50% AND 100% MIXTURE OF SHREDDED ROOT AND TRUNK PARTS ON GERMINATION OF TOMATO SEEDS (THIRD BIOASSAY TEST)

Extracts	Mean Number of Seeds Germinated[1]			
	Days After Treatment			
	4	6	8	10
1. 50% mixture, 400 ml distilled water	7.33 a[2]	31.00 a	36.67 a	39.00 a
2. 50% mixture, 200 ml distilled water	3.83 c	30.50 a	37.17 a	39.17 a
3. 100% mixture, 400 ml distilled water	4.66 ac	20.00 b	25.50 ac	34.50 a
4. 100% mixture, 200 ml distilled water	4.50 c	26.67 a	34.34 c	36.17 a
5. Control, distilled water	28.83 b	45.33 c	47.66 b	48.16 b

[1]Fifty seeds per replication; two replications per treatment in each of three blocks.

[2]Means in the same column followed by the same letter are not different at the .05 level of significance using the LSD.

TABLE V

GROWTH OF PEACH SEEDLINGS PLANTED IN VARIOUS SOIL AMENDMENTS CONTAINING SHREDDED TRUNK AND ROOT PARTS

	Average Growth of Peach Seedlings[1]				
Treatments	Height (cm)	Diameter (cm)	Root Wt. (g)	Top Wt. (g)	Total Wt.[2] (g)
1. 0% shredded trunk and roots	29.10 a	.41 a	6.85 a	7.26 a	14.11 a[3]
2. 25% shredded trunk and roots	13.10 bc	.27 b	2.18 b	2.12 b	4.30 b
3. 50% shredded trunk and roots	20.36 b	.27 b	1.54 b	2.18 b	4.08 b
4. 75% shredded trunk and roots	14.06 bc	.24 b	1.57 b	1.75 b	3.32 b
5. 100% shredded trunk and roots	11.70 c	.22 b	1.10 b	.80 b	2.41 b

[1]One seedling per container, the treatments were arranged in 5 x 5 Latin square.

[2]All weights are fresh weights.

[3]Means in the same column followed by the same letter are not different at the .05 level of significance using the LSD.

TABLE VI

THE EFFECTS OF EXTRACTS FROM 50% AND 100% MIXTURE OF SHREDDED ROOT AND TRUNK PARTS ON GERMINATION OF TOMATO SEEDS (FOURTH BIOASSAY TEST)

Extracts	Mean Number of Seeds Germinated[1]			
	Days After Treatment			
	4	6	8	10
1. 50% mixture, 400 ml distilled water	1.83 a[2]	26.83 a	32.83 a	35.16 a
2. 50% mixture, 200 ml distilled water	2.67 a	22.50 a	32.00 a	34.33 a
3. 100% mixture, 400 ml distilled water	4.67 a	28.50 a	33.67 a	36.67 a
4. 100% mixture, 200 ml distilled water	3.83 a	25.16 a	31.83 a	34.66 a
5. Control, distilled water	10.67 b	48.00 b	49.00 b	49.00 b

[1]Fifty seeds per replication, two replications per treatment in each of three blocks.

[2]Means in the same column followed by the same letter are not different at the .05 level of significance using the LSD.

TABLE VII

THE GROWTH OF ONE-YEAR-OLD PEACH SEEDLINGS PLANTED IN VARIOUS SOIL AMENDMENTS OF SHREDDED TRUNK AND ROOT PARTS[1]

Treatments	Average Growth of Peach Seedlings[2]			
	Length of New Growth (cm)	Root Wt. (g)	Top Wt. (g)	Total Wt.[3] (g)
1. 0% shredded trunk and roots	1150.50 a	152.30 a	346.20 a	1302.80 a[4]
2. 10% shredded trunk and roots	469.30 b	80.70 b	176.90 b	550.00 b
3. 20% shredded trunk and roots	711.80 bc	63.10 b	146.40 bc	774.90 c
4. 30% shredded trunk and roots	300.20 bcd	74.40 b	160.10 b	374.60 d
5. 40% shredded trunk and roots	265.50 cd	50.00 b	134.70 bc	315.50 d
6. 50% shredded trunk and roots	159.20 d	41.80 b	95.30 c	201.00 e

[1]Trees were planted February 11, 1977 and harvested May 14, 1977.

[2]One seedling per replication; two replications per treatment in each of four blocks.

[3]All weights are fresh weights.

[4]Means in the same column followed by the same letter are not different at the .05 level of significance using the LSD.

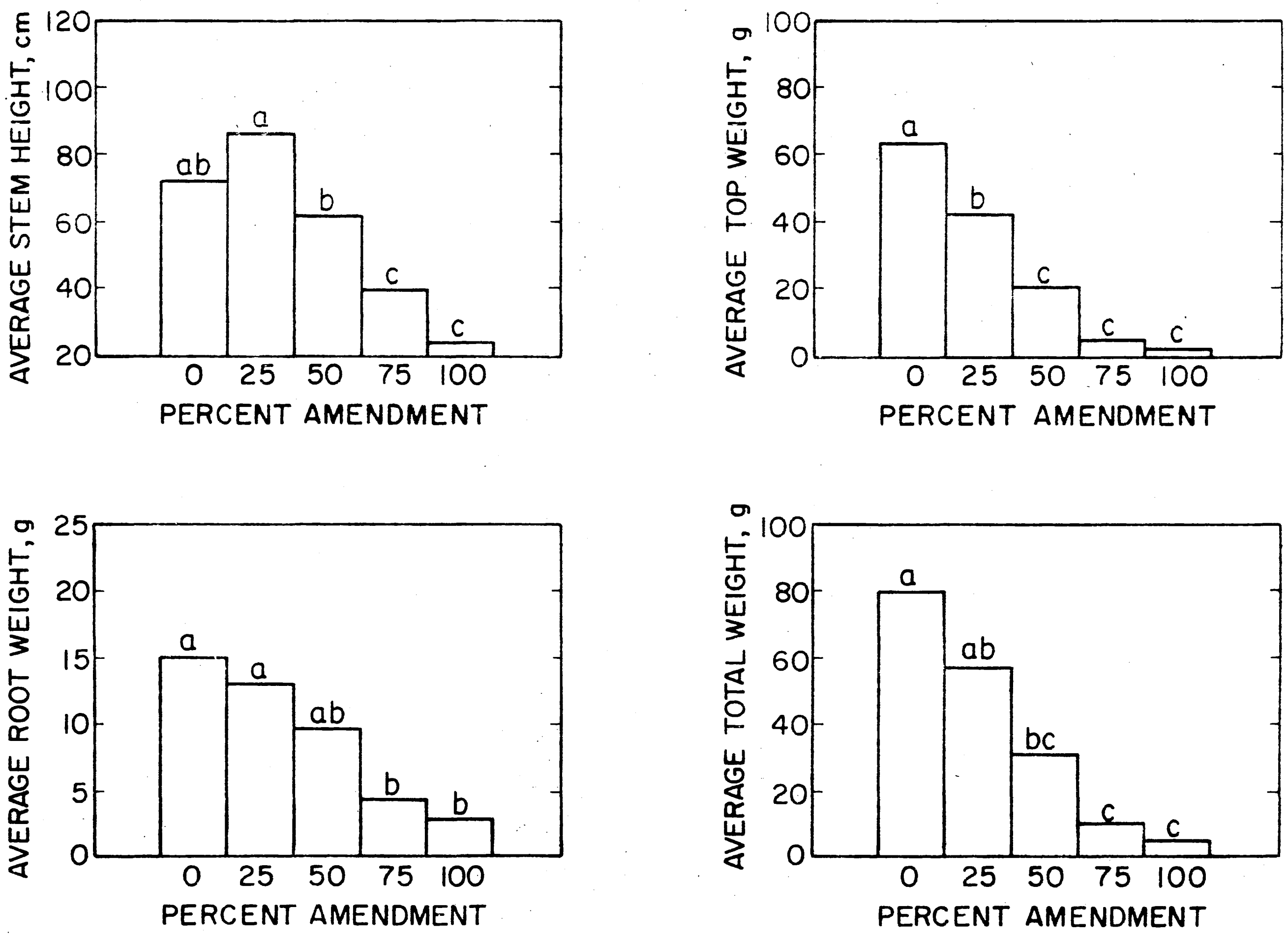

Figure 6. Average Growth of Peach Seedlings When Grown from Seed in Various Soil Amendments Containing Shredded Root and Trunk Parts

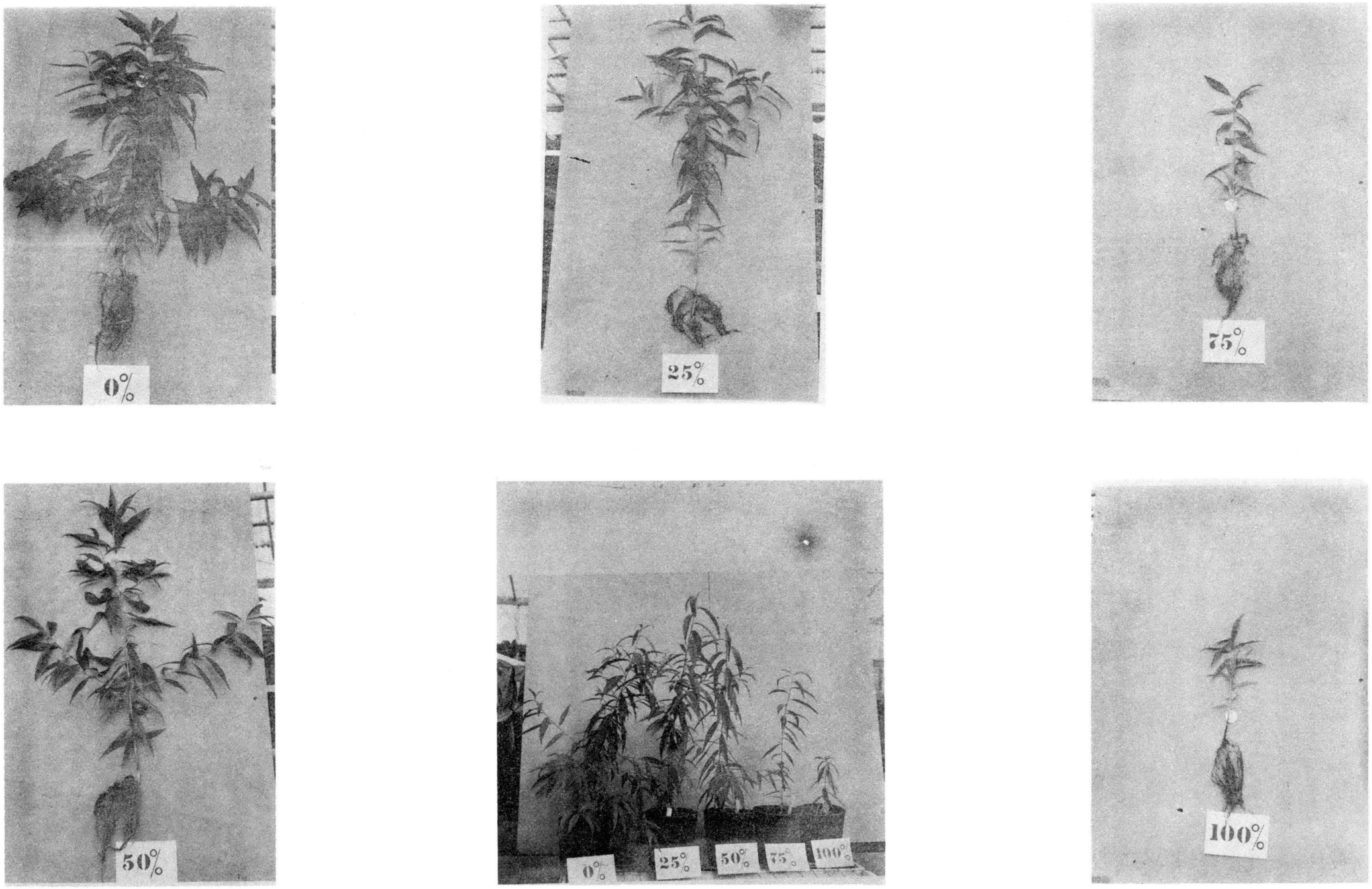

Figure 7. Peach Seedlings Showing Root and Top Growth in Various Soil Amendments of Shredded Root and Trunk Parts by Planting Seed Directly into the Mixtures

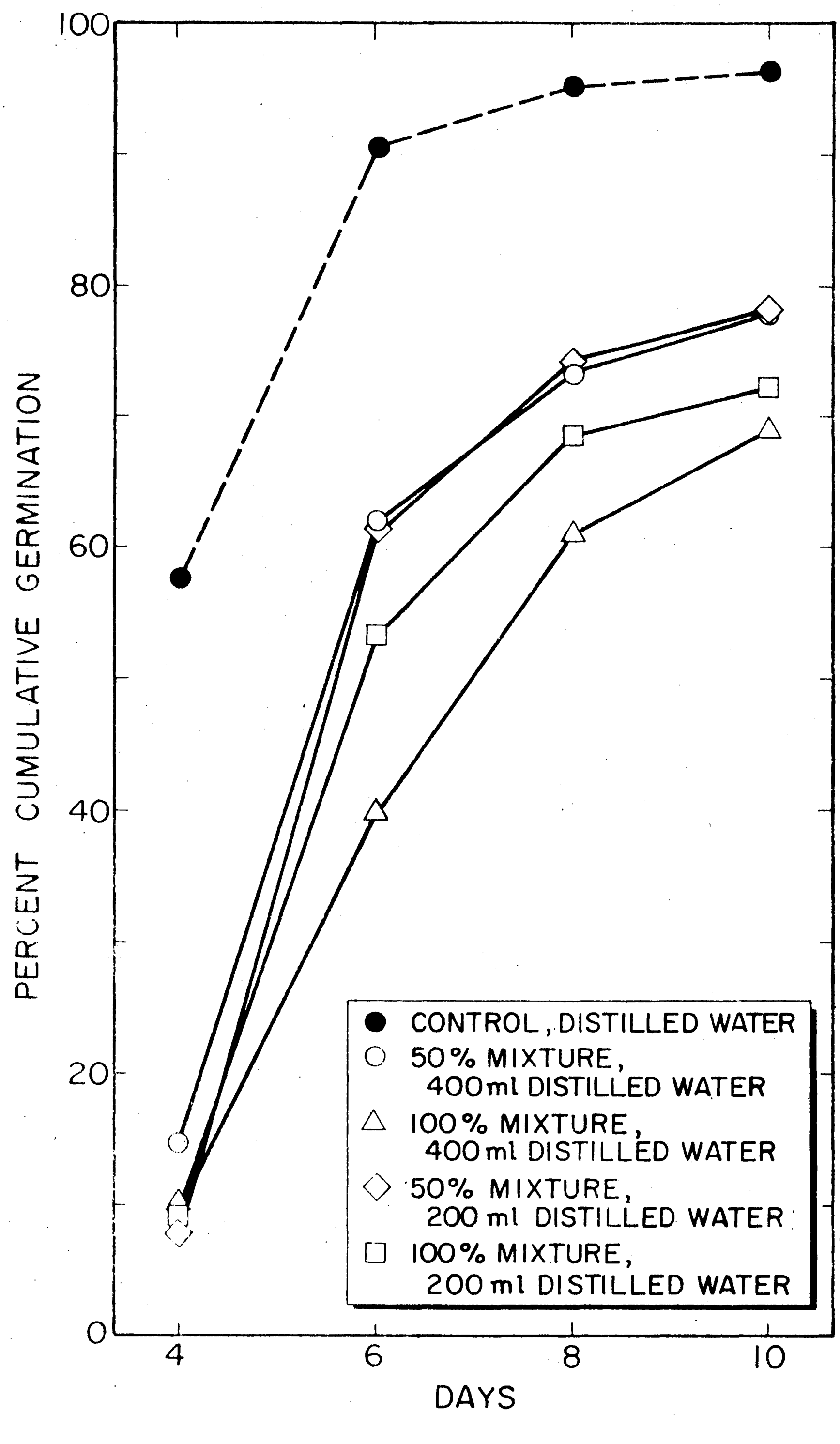

Figure 8. Effect of Extracts from 50% and 100% Mixtures of Shredded Root and Trunk Parts on Germination of Tomato Seed (Third Bioassay Test)

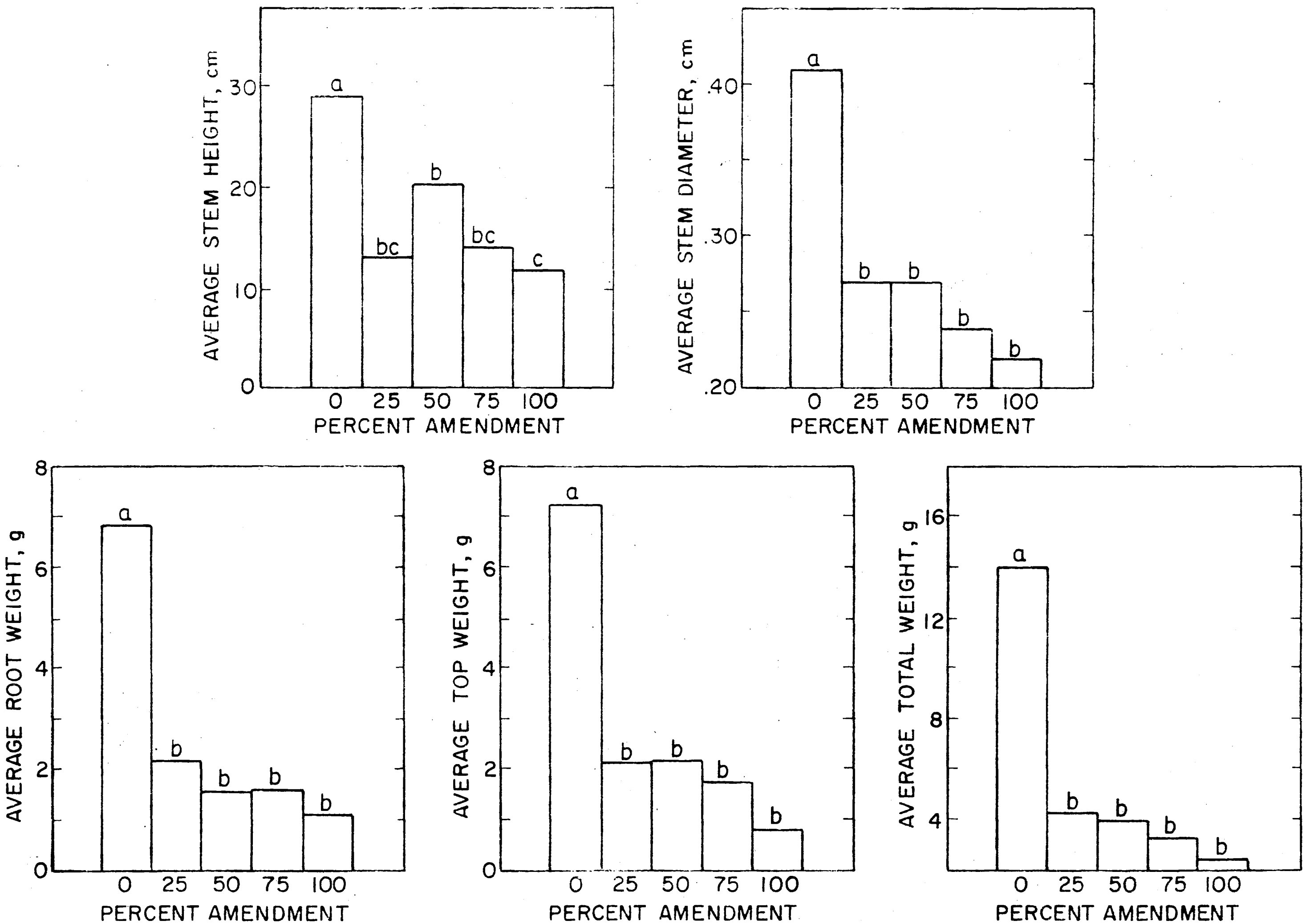

Figure 9. Average Growth of Peach Seedlings Planted in Various Soil Amendments Containing Shredded Root and Trunk Parts

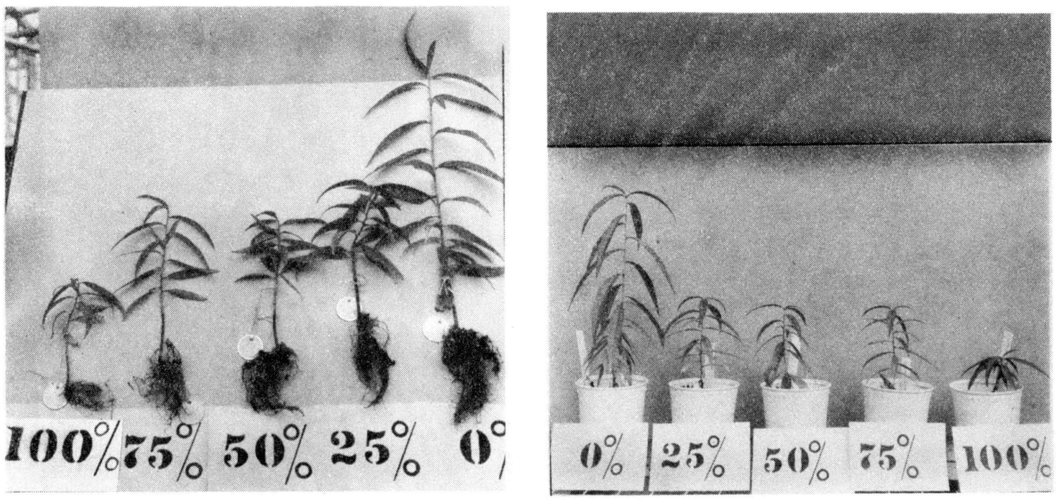

Figure 10. Peach Seedlings Showing Root and Top Growth in Various Mixtures of Shredded Root and Trunk Parts

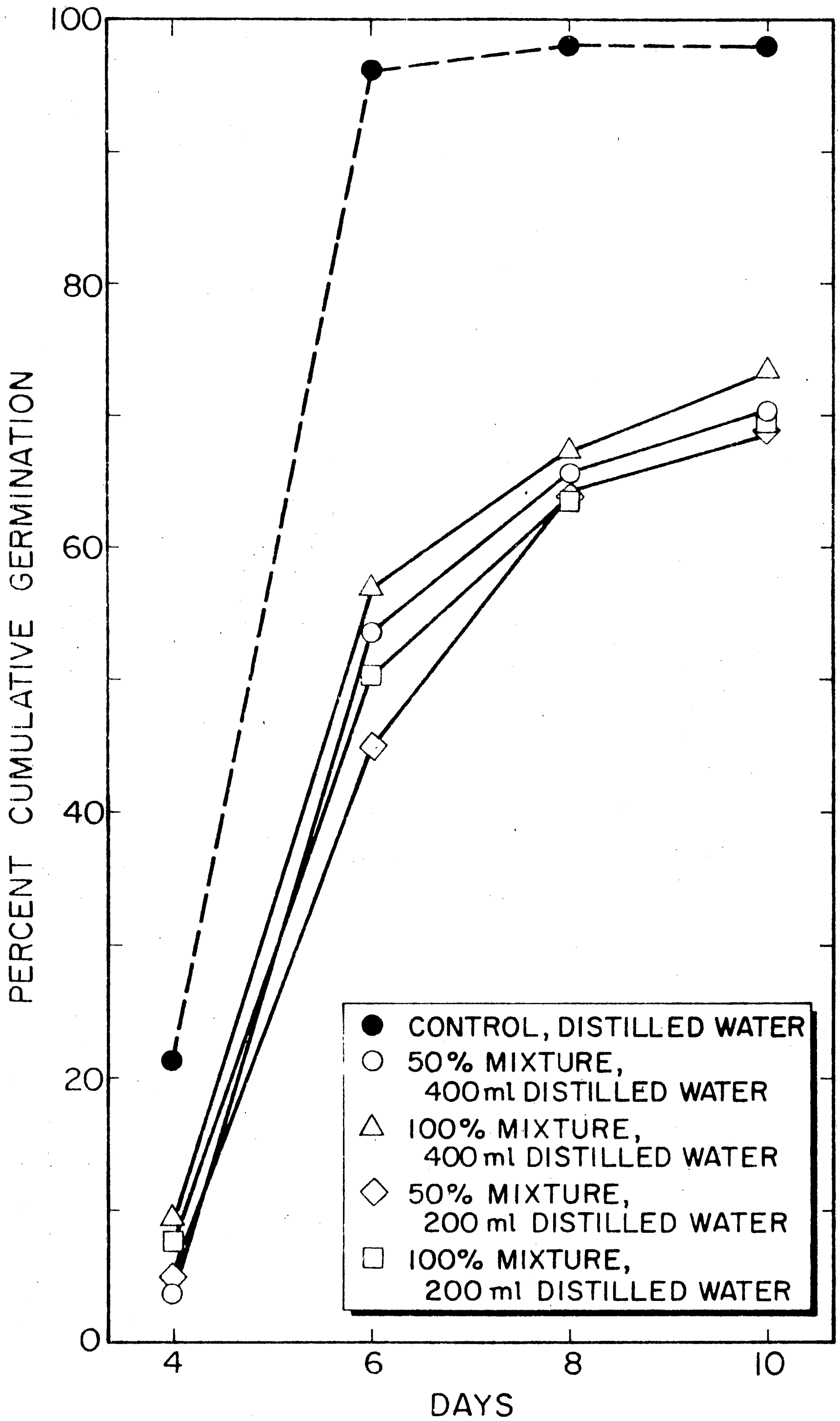

Figure 11. Effect of Extracts from 50% and 100% Mixtures of Shredded Root and Trunk Parts on Germination of Tomato Seed (Fourth Bioassay Test)

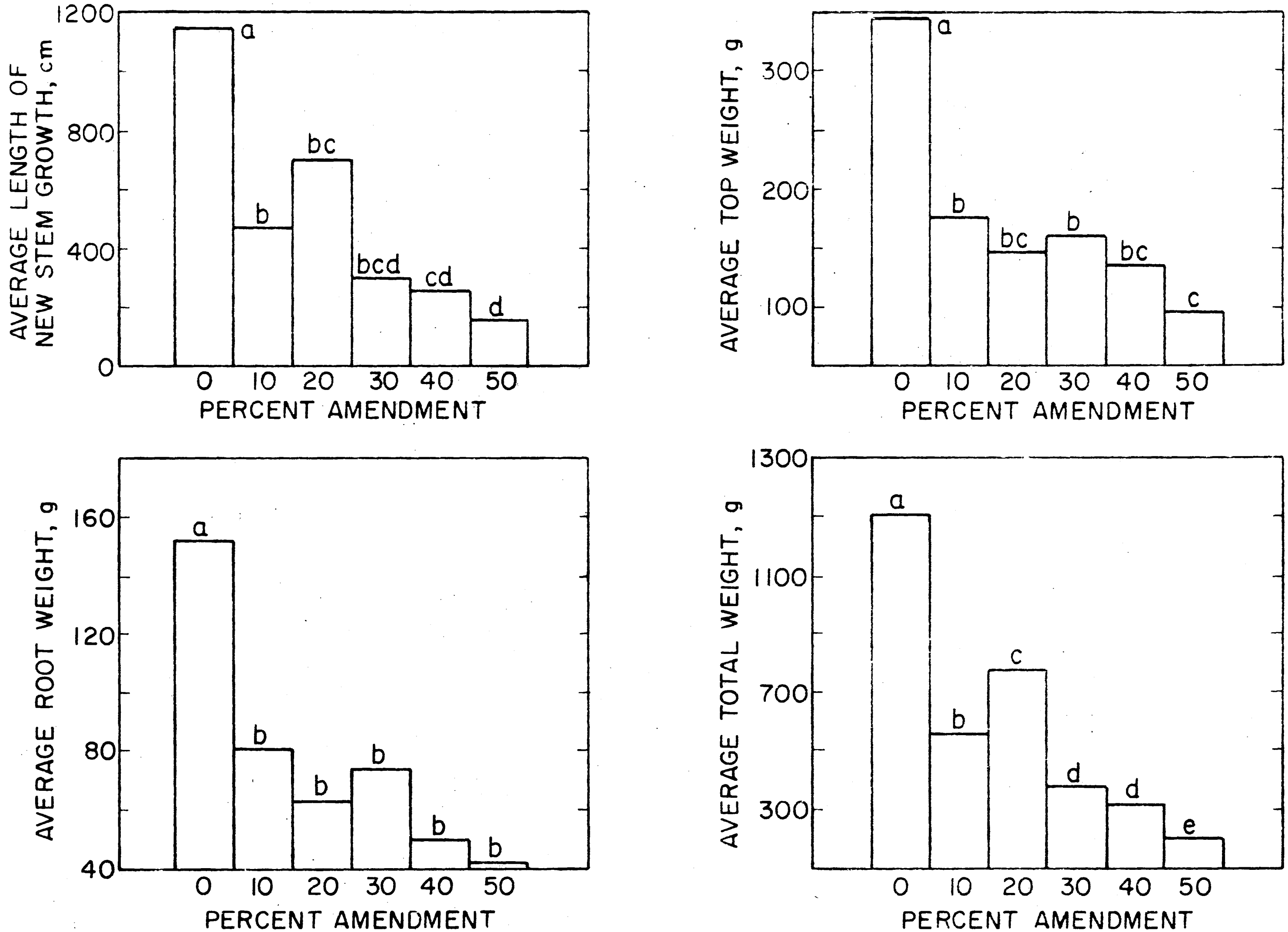

Figure 12. Average Growth of One-Year-Old Seedlings Planted in Various Soil Amendments Containing Shredded Root and Trunk Parts

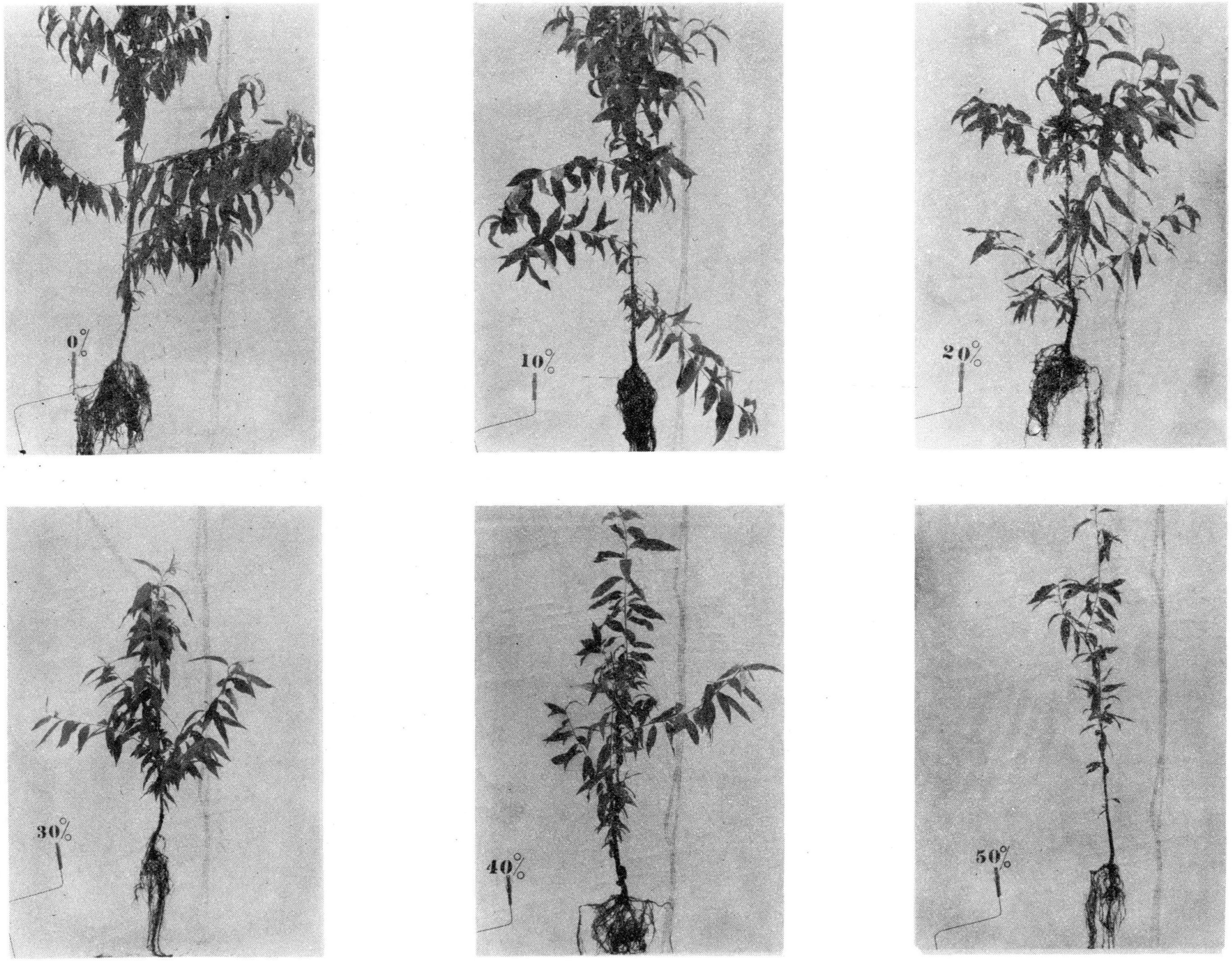

Figure 13. Peach Trees Showing Root and Top Growth in 0% to 50% Soil Amendments of Shredded Root and Trunk Parts, Growing in Three-Gallon Containers

TABLE VIII

GROWTH RESPONSE OF PEACH SEEDLINGS GROWING IN SOIL
TREATED WITH HYDRATED LIME

Amount of Lime Added/Ha	g of Lime Per Container	Average Growth of Peach Seedlings[1]			
		Length of New Growth (cm)	Root Wt. (g)	Top Wt. (g)	Total Wt. (g)
1. Unlimed, 0	0.0	284.00 a	22.88 a	119.75 a	142.63 a[2]
2. Limed, 2500 kilograms	31.2	298.38 a	26.00 a	132.75 a	158.75 a
3. Limed, 5000 kilograms	62.5	330.63 a	30.25 a	130.50 a	160.75 a

[1]One seedling per replication; two replications per treatment in each of four blocks.

[2]Means in the same column followed by the same letter are not different at the .05 level of significance using the LSD.

Response of Lime Application

The soil in old peach sites became quite acid, which may have caused the trees to undergo poor growth. After 91 days of treatment the pH changed from 4.3 to 6.9 in the treatment limed at 5000 kilograms per hectare (Table VIII). The growth of shoots and roots of the seedlings increased as the lime content increased. The difference in treatments was not significant for the duration of the experiment (Table VIII and Figure 14). Prince and Harris (19) found liming at the rate of 2500 kilograms per hectare neither increased shoot growth nor produced larger, greener leaves. The higher rate of lime (5000 K/Ha) depressed growth in the beginning but it later improved.

TABLE IX

EFFECT OF VARIOUS RATES OF HYDRATED LIME ON SOIL pH

	Soil pH		
	Amount Lime Applied		
Date	Unlimed	2500 K/Ha	5000 K/Ha
April 14, 1977	5.0	6.7	7.1
May 18, 1977	5.0	6.4	6.9

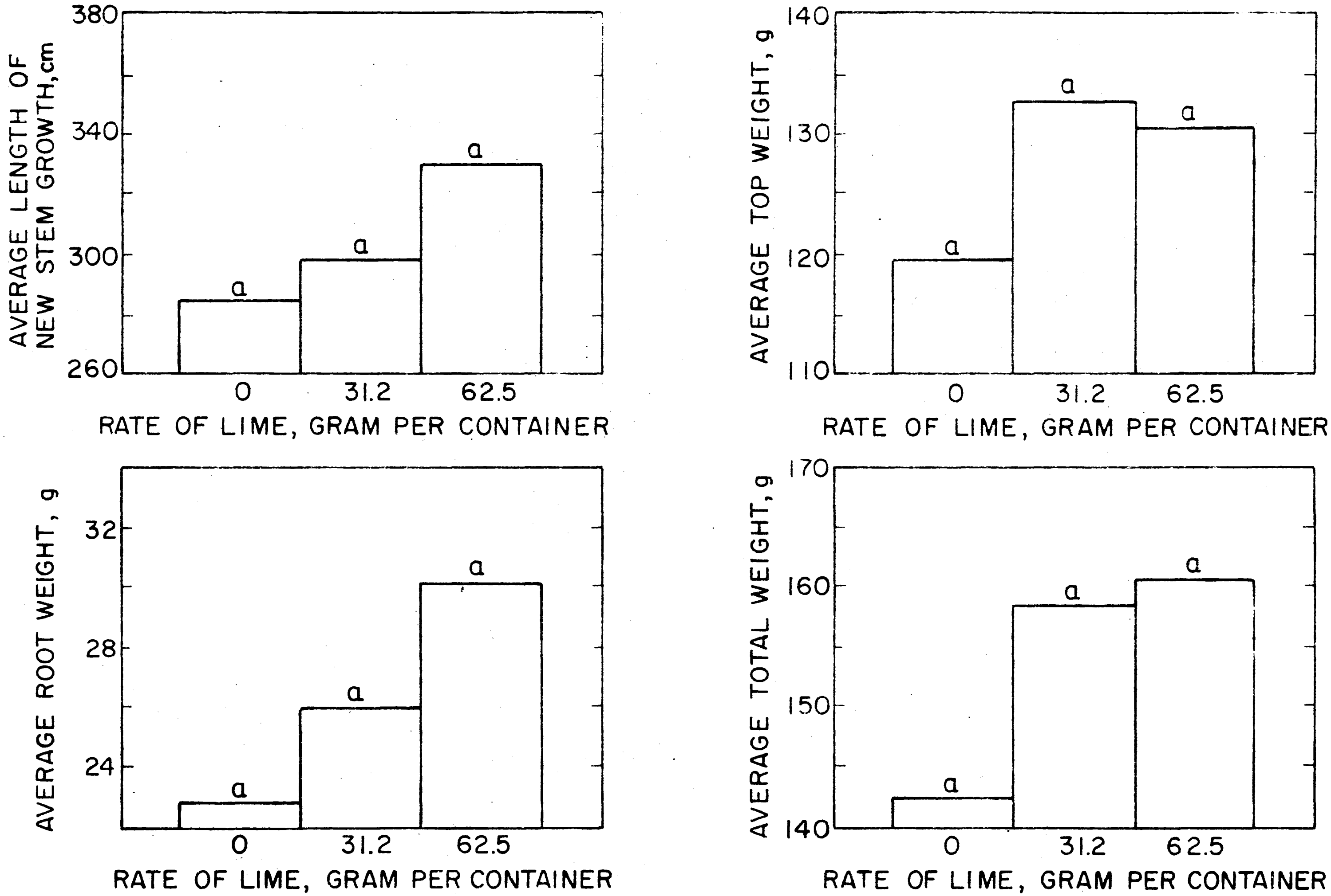

Figure 14. Average Growth of Peach Seedlings 91 Days after Soil Treatment with Hydrated Lime

CHAPTER V

SUMMARY AND CONCLUSIONS

The replanting problem present in old peach orchard sites is probably due to the development of toxic materials resulting from the decomposition of peach roots left in the soil. Although a toxic material has been suspected for some time, it has been very difficult to prove its existence in controlled laboratory or greenhouse experiments. High acidity in the soil of old peach orchards and the resulting low availability of some minerals such as calcium, magnesium and phosphorus may be other reasons for peach decline.

The purpose of this study was to investigate relative importance of toxic soil substances in the peach replant problem by determining whether toxic materials were present in peach tree parts and to compare their toxic content by studying the effect of extracts on germination of tomato seeds. A further investigation involved growing of peach seedlings in various soil amendments containing shredded trunk and root parts to determine the effect of root and trunk residue on growth of peach seedlings. Finally, various rates of lime were added to soil from an old peach site to determine if liming might reduce peach tree decline.

Throughout the bioassay tests there was no evidence that any toxic substance in extracts of trunk and stony pericarps adversely affected the germination of tomato seeds. Extracts of decaying roots over and under 20 mm in diameter and roots under 20 mm in diameter from a dying tree did not show significant difference in germination inhibition when compared to the control 13 days after treatment. The per cent germination following treatment by the extract of decaying roots under 20 mm in diameter approximates those results obtained from extract of roots under 20 mm in diameter from the decaying roots. Water-solubility of toxic substances such as hydrogen cyanide may result in the toxin being leached from the soil. This might explain the result obtained from extract of decaying roots in bioassay tests. Although it is reported (7) that root tissues contain more amygdalin than stem tissue, root extracts did not show any inhibition on germination nine days following treatment, while extracts of stems reduced germination 6.8 percent. From results of bioassay tests it was also demonstrated that some type of germination inhibitor is present in the extracts of leaves and kernels and was available in significant concentrations to decrease the per cent of germination by 58.6 percent and 16.0 percent, respectively. It is recognized that much of the response obtained in bioassay tests is not well understood.

The results of seedling experiments conducted showed that the growth of peach seedlings in different soil amendments of shredded root and trunk tissues was significantly reduced as the peach soil mixture increased. Germination tests used to investigate the toxic effects of the soil water leachates containing 50 percent and 100 percent peach root and turnk residue showed that depletion of nutrients by soil organisms using the peach residues as a source of energy is not an adequate explanation for the poor growth of seedlings grown in various soil mixtures. Presence of some microorganisms in soil containing decomposed peach tree parts may be the reason for poor growth of peach seedlings grown in soil containing shredded root and trunk.

The benefits obtained from adding 2500 and 5000 kilograms of hydrated lime per hectare to soil of an old peach orchard improved the growth of peach seedlings. The differences in shoot and root growth and total weight of seedlings were not sufficient to be of statistical significance when compared to growth of seedlings grown in soil with no lime added. The experiment was conducted for a period of only three months; consequently, the trees may not have had the time to utilize available calcium or phosphorus.

The difficulty of re-establishing peach trees in soils which previously supported a peach orchard has become more serious. The problem involves many different factors and interrelationships. It is of primary importance to study each factor separately in order to adequately investigate this problem.

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VITA

Nasrin Sadrian

Candidate for the Degree of

Master of Science

Thesis: THE EFFECT OF WATER SOLUBLE EXTRACTS FROM PEACH PARTS ON BIOASSAYS OF TOMATO AND THE EFFECT OF PEACH ROOT SOIL AMENDMENTS AND LIME ON GROWTH OF PEACH SEEDLINGS

Major Field: Horticulture

Biographical:

Personal Data: Born in Tehran, Iran, March 22, 1951, the daughter of Mr. and Mrs. A. H. Sadrian.

Education: Graduated from Farah High School in 1969; received the Bachelor of Science degree in Agriculture from Pahlavi University in 1974; completed requirements for the Master of Science degree in Horticulture at Oklahoma State University in December, 1977.