THE EFFECTS OF CERTAIN FERTILIZER NUTRIENTS USED AS STARTER SOLUTIONS WHEN APPLIED TO MONTMORENCY CHERRY TREES AT PLANTING TIME

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INTRODUCTION

An inadequate supply of certain nutrients at planting time may result in poor growth of fruit trees. However, applications of fertilizers at planting time are not commonly used because they often result in deleterious effects. A shortage of nutrient supply when the trees are first planted may be more detrimental than in later years because the roots of the young trees are severely pruned when removed from the nursery.

Cherry trees usually fail to make as much terminal growth as apple or peach trees during the first year in the orchard. This shorter terminal growth has been believed to be associated with the removal of the carbohydrate supply by root pruning and to the inherent characteristics of the cherry tree. The reduction of the root system also reduces the absorption of nitrogen and other nutrients. However, many of the cherry orchards being planted in Michigan have been showing symptoms of nutrient deficiency during the first year after planting. Applications of fertilizers to correct a nutrient shortage are usually made during the dormant period following the season the trees are planted.

The present experiment was established to explore some of the effects of using solutions of certain fertilizers on young cherry trees at planting time. The primary objectives of the experiment were to determine the effects of such solutions upon the terminal growth of newly planted cherry trees and the prevention of the occurrence of deficiency symptoms during the season the trees were planted.

REVIEW OF LITERATURE

Tukey (18), working with soils of low fertility, ranked the effects of several fertilizers upon the growth of apple whips if applied at planting time. The dry fertilizers were applied in the holes and on the surface of the soil. Bone meal applied in the holes and urea applied on the surface increased growth. Acid phosphate did not influence growth. Cyanamid, muriate of potash, nitrate of soda, ammonium sulphate, hen manure, and ammonium phosphate decreased growth. The decrease in growth resulting from fertilizers applied was proportional to the amount applied. This would indicate that the injury resulted from plasmolysis of young root tissue rather than a chemical reaction.

Lilleland (6) applied twenty pounds per tree of treble superphosphate in the hole at planting to apple, apricot, prune, and peach trees. The soil in which the trees were planted was extremely low in phosphorus. Shoot growth, root growth, and cross sectional area of the trunk were greatly increased. The phosphorus content of the leaves increased from 200-300 percent of that found in leaves of trees not treated.

Schwartze and Myrhe (11, 12) state that an increase in growth of blueberry hardwood cuttings was obtained from applications of nitrogen fertilizers. The plants were grown in beds of peat-sand mixture and responses were obtained from applications of ammonium phosphate, ammonium nitrate, ammonium sulphate, and sodium nitrate, singly or in combination with phosphorus and potash. Increased shoot growth was still evident in the plants after two years.

Sitton (13) applied ammonium nitrate, superphosphate, and muriate of potash to tung trees soon after planting. He reported that 0.08 - 0.16 of a pound of phosphate per tree increased linear growth, whereas results from trees on which potash was applied were inconsistent. Where leaf composition varied from 1.92 - 1.94 percent nitrogen, applications of nitrogen increased growth. When leaf composition was above 2.25 percent nitrogen, applications of nitrogen had little effect and when leaf composition was over 2.54 percent nitrogen, applications of nitrogen depressed growth.

Baker (1) stated that on soils relatively low in available phosphorus, the phosphoric acid or other soluble phosphates used in the proper dilution at planting time, started tomato plants out more rapidly, reduced replanting, and increased early fruiting. The same responses were observed by Stair and Hartmann (15) who reported that early yields on tomato were increased by the application of a pint of starter solution per plant. The solution was prepared by mixing two pounds of treble superphosphate, one pound of calcium nitrate and one pound of potassium nitrate in fifty gallons of water.

Carrier and Snyder (2) applied twenty-five cubic centimeters of a starter solution to four different floricultural crops. The solution was prepared by dissolving four pounds of mono-ammonium phosphate, two pounds of potassium phosphate, and two pounds of potassium nitrate in fifty gallons of water. Survival and height gain were increased with Taxus. Days to flowering were decreased with Antirrhinum majus and Delphinium. No significant differences were observed with Forsythia.

Reath (8) applied one-half pint of a starter solution per plant to several varieties of strawberries. The solution consisted of six pounds of a 10-52-17 fertilizer per fifty gallons of water. Varieties differed in response. However, an average of all varieties tested showed that when the starter solution was applied, there was an increase in runner formation which was followed by an increase in yield.

Jacob and White-Stevens (4), working with cauliflower and brussels sprouts declared water was as beneficial as starter solutions when applied at transplanting time. However, they partially accounted for the lack of response as being associated with high levels of soil fertility.

Sayre (9, 10) reported that the principal effect of a starter solution was to enable the plant to become established more quickly and was particularly effective under conditions where the plants were low in nutrients at transplanting time.

Tiedjens and Schermerhorn (16) cited some advantages for starter solutions when used on vegetable crops. Less fertilizer was required because that applied was more quickly available. Injury from dry fertilizers next to roots was avoided and more uniform applications of fertilizer could be made. Fertilizers of poor physical condition could be applied more satisfactorily. Plant responses were often obtained in dry weather.

There has been a considerable amount of experimental work done on the effects of starter solutions on various crops. Much of this work, however, is not reported in scientific publications. A tabulation of several commercial preparations and the recommended application rates is presented in Appendix Table 11.

PROCEDURE

The experiment was located near Traverse City, Michigan, on a sandy loam soil. Several crops of alfalfa had been previously grown on the field followed by a clover sod which was plowed down in the spring before planting.

Two hundred and ten, 7/16 inch cherry trees of the Montmorency variety (*Prunus cerasus* L.) budded on Mahaleb rootstocks were obtained during the fall of 1951 and "heeled in" over winter. The trees were pruned to whips and set twenty-two feet apart, on the square, in 21 rows during May of 1952. A view of the plot layout is presented in Figure I.

Nine solutions of fertilizer materials were prepared. The composition of these solutions is shown in Table 1 (see also Appendix Table 11). The solutions were applied at rates of one gallon and two gallons per tree with each solution being applied at both rates to ten trees.

Suitable sized holes were dug with a tractor mounted post hole digger. The trees were then placed in the proper position in the holes and enough soil was placed and firmed on and around the roots to hold the trees in place. This left a reservoir around the tree about six to eight inches deep and twelve to eighteen inches in diameter.

The solutions were then poured into the reservoir. After the solutions had drained into the soil the remaining

Figure I. A view of the experimental orchard showing topography, planting plan and cover on November 1, 1952

TABLE 1

THE COMPOSITION OF STARTER SOLUTIONS APPLIED TO YOUNG MONTMORENCY CHERRY TREES AT PLANTING TIME

Solution number	Treatment designation	Amount per gallon of water*		
		Ammonium nitrate	Phosphoric acid (85%)	Potassium chloride
		gm	cc	gm
1	N	17.3	-	-
2	P	-	4	-
3	K	-	-	9.1
4	NP	17.3	4	-
5	NK	17.3	-	9.1
6	PK	-	4	9.1
7	NPK	17.3	4	9.1
8**	NPK + TE	17.3	4	9.1
9**	TE	-	-	-

*Amount per 100 gallons in Appendix Table 12.

**Trace element mixture added. Composition of the mixture was:

57.0 gm magnesium sulphate	1.1 gm copper sulphate
2.4 gm boric acid	0.8 gm ferrous sulphate
2.0 gm manganous sulphate	0.6 gm zinc sulphate

portion of the holes were filled.

The trees were clean cultivated for a distance of approximately three feet on each side of the row, trashy cultivation being used between the clean cultivated areas. Five sprays of proprietary copper compounds were applied during the growing season for control of cherry leaf spot. Three additional s prays of D.D.T. and parathion were applied, in late June, for rose chafer control. No fertilizers other than those used in the solutions were applied.

Trunk diameter was measured for each tree on May 11 and on November 1. The total amount of linear growth per tree was measured on November 1.

A sample of leaves was taken from each treatment on November 1. Ten leaves from each of the ten trees in a treatment were taken from the median section of various branches around the tree. A damp cheesecloth was used to wipe off dirt and any spray residue that might have been present. The leaf samples, both petioles and blades, were air dryed and ground together in a Wiley mill.

The ground samples from each treatment were analyzed in the Agricultural Chemistry Laboratories. Total nitrogen was determined by Kjeldahl method. Potassium was determined by use of the flame photometer. Phosphorus, boron, magnesium, calcium, manganese, iron, and copper were determined by use of the spectrograph. Leaf analysis values were expressed as percent dry weight.

Soil samples were collected on November 1 from the area in the root zone where solutions had been applied in May. This was accomplished by use of a soil sampling tube. The tube was inserted into the soil to a depth of eighteen inches and a core of soil removed. The bottom six inches of soil from the core was taken as the sample, one core being taken for each tree. A composite sample from each treatment, made by mixing the cores from the ten trees in the treatment, was tested. Both active and reserve soil tests, Spurway and Lawton (14), were employed to determine whether nutrient concentration had changed appreciably in the root zone, by the addition of the starter solutions.

RESULTS

Growth

The influence of the starter solutions on increase in trunk diameter of young cherry trees is recorded in Table 2.

At the one gallon level, an application of water without any nutrients added resulted in a greater increase in trunk diameter than that found for check trees. Two treatments, K and PK, resulted in a significantly greater increase in trunk diameter than occurred for those trees to which only water had been applied. Other treatments (N, P, NP, NK, and NPK) resulted in a slightly greater increase in trunk diameter than water alone. Treatments NPK plus TE and TE resulted in less increase in trunk diameter than when only water was applied.

At the two gallon level, the application of water again resulted in a greater increase in trunk diameter than that of check trees. Treatments N, P, K, and PK resulted in a greater diameter increase than the treatment with water alone. None of the increases in trunk diameter were significant. However, trunk diameter increases resulting from treatments NP, NPK plus TE and TE were significantly less than when water alone was applied.

Comparing the two levels of application, one gallon levels of K and PK resulted in a significantly greater

TABLE 2

THE INFLUENCE OF CERTAIN STARTER SOLUTIONS ON INCREASE IN TRUNK DIAMETER OF YOUNG SOUR CHERRY TREES

(Averages of Ten Trees)

Solution number	Treatment designation	Amount applied	
		One gallon	Two gallons
		mm	mm
1	N	5.13	4.69
2	P	4.65	5.61
3	K	5.99	4.65
4	NP	4.59	3.12
5	NK	4.76	4.32
6	PK	6.15	4.65
7	NPK	5.00	4.01
8	NPK + TE	3.54	2.37
9	TE	3.83	1.84
	Water	4.10	4.51
	Check	3.33	

Least Significant Difference: 5% - 1.34; 1% - 1.77

diameter increase than an application of two gallons of water. The treatments at the two gallon level of P and water increased trunk diameter slightly more than the same treatments at the one gallon level. All other treatments at the two gallon level resulted in less diameter increase than the same treatments at the one gallon level.

A tabulation of the influence of starter solutions on the terminal growth of young cherry trees is provided in Table 3.

No significant increases in terminal growth were obtained. However, treatments at the one gallon level of N, K, and PK increased terminal growth as compared with terminal growth of check trees. Treatments NPK, NPK plus TE and TE resulted in a decrease in terminal growth when compared to check trees.

Treatments P, K, and PK at the two gallon level resulted in an increase in terminal growth. Whereas, treatments NP, NPK, NPK plus TE and TE resulted in a decrease in terminal growth as compared to check trees.

Comparing the two levels of application, treatments P, K, and PK resulted in a greater increase in terminal growth at the two gallon level than at the one. All other treatments resulted in less terminal growth at the two gallon level of application than at the one.

Leaf Composition

A tabulation of the influence of one gallon of various

TABLE 3

THE INFLUENCE OF CERTAIN STARTER SOLUTIONS ON TERMINAL GROWTH OF YOUNG SOUR CHERRY TREES

(Average of Ten Trees)

Solution number	Treatment designation	Amount applied	
		One gallon	Two gallons
		cm	cm
1	N	171.4	142.3
2	P	143.9	187.0
3	K	160.8	172.8
4	NP	149.4	98.3
5	NK	133.2	132.5
6	PK	159.4	171.1
7	NPK	124.1	121.2
8	NPK + TE	102.1	102.9
9	TE	120.8	96.2
	Water	127.8	140.6
	Check	141.7	

Least Significant Difference: 5% - 47.18; 1% - 62.29

starter solutions on leaf nitrogen, phosphorus, potassium, and calcium is given in Table 4.

The percentage of nitrogen in the leaves increased from 2.20 to 2.60 percent following an application of K. In treatment NPK, leaf nitrogen increased from 2.20 to 2.51 percent and in treatments NP and PK, from 2.20 to 2.47 percent.

The phosphorus level in the leaves increased from 0.152 to 0.184 percent in treatments NP and TE, from 0.152 to 0.178 percent in treatment PK; but decreased from 0.152 to 0.105 percent in treatment NPK plus TE.

An application of NPK resulted in an increase in leaf potassium from 0.622 to 1.00 percent, from 0.622 to 0.969 percent in treatment PK, from 0.622 to 0.930 percent in treatment K, and from 0.622 to 0.890 percent in treatment NK. A decrease in leaf potassium resulted from applications of N, P, NP, and TE.

Calcium, in the leaves, increased from 2.53 to 3.10 percent following an application of phosphorus (P) but decreased from 2.53 to 0.85 percent in the NPK treatment.

The influence of applications of two gallons of the starter solutions on leaf nitrogen, phosphorus, potassium and calcium is given in Table 5.

Following an application of NPK, leaf nitrogen increased from 2.20 to 2.52 percent but decreased from 2.20 to 2.03 percent with an application of trace elements (TE).

Leaf phosphorus increased from 0.152 to 0.208 percent

TABLE 4

LEAF COMPOSITION AS INFLUENCED BY APPLICATIONS OF ONE GALLON OF VARIOUS STARTER SOLUTIONS

(Percent dry weight)

Solution number	Treatment designation	Leaf composition			
		Nitrogen	Phosphorus	Potassium	Calcium
		%	%	%	%
1	N	2.42	0.169	0.560	1.87
2	P	2.31	0.161	0.580	3.10
3	K	2.60	0.166	0.930	1.26
4	NP	2.33	0.163	0.537	2.97
5	NK	2.47	0.184	0.890	2.03
6	PK	2.47	0.178	0.969	1.78
7	NPK	2.51	0.134	1.000	0.85
8	NPK + TE	2.30	0.105	0.620	2.52
9	TE	2.16	0.184	0.505	2.50
	Water	2.16	0.147	0.619	1.86
	Check	2.20	0.152	0.622	2.53

TABLE 5

LEAF COMPOSITION AS INFLUENCED BY APPLICATIONS OF TWO GALLONS OF VARIOUS STARTER SOLUTIONS

(Percent dry weight)

Solution number	Treatment designation	Leaf composition			
		Nitrogen	Phosphorus	Potassium	Calcium
		%	%	%	%
1	N	2.38	0.181	0.522	2.79
2	P	2.13	0.173	0.522	1.71
3	K	2.39	0.114	0.960	1.84
4	NP	2.40	0.169	0.596	1.57
5	NK	2.40	0.139	0.864	1.21
6	PK	2.35	0.141	0.899	1.02
7	NPK	2.52	0.136	1.05	2.40
8	NPK + TE	2.20	0.208	0.585	2.91
9	TE	2.03	0.152	0.573	1.63
	Water	2.26	0.162	0.712	1.35
	Check	2.20	0.152	0.622	2.53

in the treatment NPK plus TE, whereas in treatment K, the level decreased from 0.152 to 0.114 percent.

Potassium, in the leaves, increased from 0.622 to 1.05 percent following an application of NPK, from 0.622 to 0.960 percent in treatment PK, and from 0.622 to 0.864 percent in the NK treatment.

Leaf calcium varied considerably. Two values were outstanding, however. An application of NPK plus TE resulted in an increase from 2.53 to 2.91 percent and an application of PK resulted in a decrease from 2.53 to 1.02 percent.

The content of magnesium, manganese, iron, copper, and boron in the leaves as influenced by one gallon applications of the various starter solutions is given in Table 6.

Treatments NP and TE resulted in a slight increase in leaf magnesium. Treatment N resulted in a decrease in magnesium from 0.743 to 0.266 percent and treatment NPK plus TE resulted in a decrease from 0.743 to 0.258 percent.

Manganese, in the leaves, increased from 0.0063 to 0.0120 percent following an application of NK, from 0.0063 to 0.0106 percent in treatment NPK, and from 0.0063 to 0.0098 percent in the K treatment. Leaf manganese decreased from 0.0063 to 0.0026 percent in treatment NPK plus TE.

The iron content of the leaves remained nearly constant except for the treatment NPK plus TE. In this treatment the iron content decreased from 0.016 to 0.008 percent.

The amount of copper in the leaves increased from

TABLE 6

LEAF COMPOSITION AS INFLUENCED BY APPLICATIONS OF ONE GALLON OF VARIOUS STARTER SOLUTIONS

(Percent dry weight)

Solution number	Treatment designation	Leaf composition				
		Magnesium	Manganese	Iron	Copper	Boron
		%	%	%	%	%
1	N	0.266	0.0043	0.014	0.0049	0.0039
2	P	0.782	0.0079	0.015	0.0054	0.0034
3	K	0.529	0.0098	0.019	0.0050	0.0033
4	NP	0.818	0.0081	0.015	0.0067	0.0036
5	NK	0.620	0.0120	0.017	0.0074	0.0036
6	PK	0.490	0.0073	0.015	0.0063	0.0034
7	NPK	0.436	0.0106	0.015	0.0056	0.0030
8	NPK + TE	0.258	0.0026	0.008	0.0067	0.0104
9	TE	0.865	0.0059	0.014	0.0092	0.0164
	Water	0.523	0.0049	0.015	0.0071	0.0033
	Check	0.743	0.0063	0.016	0.0071	0.0036

0.0071 to 0.0092 percent following an application of trace elements (TE) which contained copper. Other values for leaf copper were within a narrow range.

The boron content of the leaves varied from 0.0033 to 0.0039 percent except for two treatments. Leaf boron increased from 0.0036 to 0.0104 percent following an application of NPK plus TE and from 0.0036 to 0.0164 percent following an application of trace elements (TE) alone.

The influence of applications of two gallons of various starter solutions on leaf magnesium, manganese, iron, copper and boron is given in Table 7.

An application of NPK plus TE resulted in an increase in leaf magnesium from 0.743 to 1.10 percent. Magnesium, in the leaves, decreased when P, K, NK, and PK were applied.

Leaf manganese increased from 0.0063 to 0.0306 percent in the NPK treatment, from 0.0063 to 0.0187 percent with an application of NK, from 0.0063 to 0.0142 percent following NPK plus TE, and from 0.0063 to 0.0123 percent in the NP treatment.

Little variation was detected in the iron content of the leaves. The percentage of iron increased slightly in the treatment NPK plus TE.

Leaf copper increased from 0.0071 to 0.0141 percent following the TE application, from 0.0071 to 0.0130 percent in the NP treatment, and from 0.0071 to 0.0105 percent in treatment NPK plus TE.

Boron, in the leaves, varied from 0.0030 to 0.0040

TABLE 7

LEAF COMPOSITION AS INFLUENCED BY APPLICATIONS OF TWO GALLONS OF VARIOUS STARTER SOLUTIONS

(Percent dry weight)

Solution number	Treatment designation	Leaf composition				
		Magnesium	Manganese	Iron	Copper	Boron
		%	%	%	%	%
1	N	0.621	0.0098	0.019	0.0080	0.0040
2	P	0.478	0.0048	0.015	0.0073	0.0039
3	K	0.486	0.0064	0.013	0.0049	0.0031
4	NP	0.581	0.0123	0.014	0.0130	0.0037
5	NK	0.443	0.0187	0.014	0.0067	0.0030
6	PK	0.462	0.0073	0.012	0.0061	0.0031
7	NPK	0.572	0.0306	0.016	0.0086	0.0033
8	NPK + TE	1.10	0.0142	0.021	0.0105	0.0179
9	TE	0.612	0.0042	0.014	0.0141	0.0251
	Water	0.627	0.0071	0.017	0.0100	0.0038
	Check	0.743	0.0063	0.016	0.0071	0.0036

percent except for two treatments. In the NPK plus TE treatment leaf boron increased from 0.0036 to 0.0179 percent and in the TE treatment boron content increased from 0.0036 to 0.0251 percent.

The application of one gallon of solution NPK plus TE resulted in a decrease in leaf magnesium, manganese, and iron, whereas two gallons of the same solution resulted in an increase in the percentage of these elements.

Level of Nutrients in the Soil

The influence of various starter solutions on phosphorus and potassium content of the soil in the root zone is given in Tables 8 and 9. Little or no effect was recorded for any treatment on the content of phosphorus as extracted in the active test. However, all treatments in which phosphorus had been applied alone or in combination with other nutrients increased the phosphorus content of the soil, as evidenced by the reserve test.

In all instances where potassium was applied either alone or in combination with other nutrients, the potassium content of the soil was increased. This increase was detected by both active and reserve tests.

Additional soil tests for pH, nitrates, calcium, magnesium, manganese, and iron are presented in Appendix Tables 13, 14, 15, and 16.

In general, the calcium level varied from 600-1000 pounds per acre as recorded by the active test. pH varied

TABLE 9

THE INFLUENCE OF TWO GALLON APPLICATIONS OF CERTAIN STARTER SOLUTIONS ON PHOSPHORUS AND POTASSIUM CONTENT OF THE SOIL

(Pounds per acre)

Solution number	Treatment designation	Phosphorus		Potassium	
		Active	Reserve	Active	Reserve
		lbs/acre	lbs/acre	lbs/acre	lbs/acre
1	N	1	5	3	26
2	P	4	15	20	20
3	K	1	4	136	116
4	NP	3	17	3	144
5	NK	2	4	64	136
6	PK	1	9	36	96
7	NPK	3	23	80	172
8	NPK + TE	1	17	40	96
9	TE	1	5	10	32
	Water	3	6	3	26
	Check	3	5	28	36

A

B

C

D

Figure II. A. Tree from the treatment where water was added. The tree shows symptoms of potassium deficiency.

B. Tree from the treatment where potassium was applied. The tree shows good growth.

C. Tree from the treatment where one gallon of a trace element mixture was added. The tree shows an accentuation of potassium deficiency symptoms.

D. Tree from the treatment where two gallons of a trace element mixture was added. The tree was defoliated and growth was reduced.

from 4.8 to 5.5. Magnesium ranged from a blank test to 40 pounds per acre and manganese from a blank test to 16 pounds per acre as shown by the active test.

DISCUSSION

The application of potassium at planting time, in the form of a starter solution, resulted in a higher percentage of potassium in the leaves, and a greater amount of available potassium in the soil in the immediate area around the roots. An increase in leaf manganese and a decrease in leaf calcium and magnesium occurred whenever potassium content was increased. This interrelationship took place without applications of magnesium, calcium, or manganese.

Trees receiving the applications of potassium showed a greater increase in trunk diameter and put on more terminal growth than check trees or trees receiving only water. The trees in the check rows evidenced signs of potassium deficiency (5). The leaves on those trees were pale green in color, with yellowish-brown edges and were usually curled or folded in shape. Terminal growth on trees treated with applications of potassium was thicker and more desirable than that of all other treatments.

The response to additions of potassium was greatly influenced by the low level of potassium in the original soil. The effects of certain other treatments, namely, N, P, and NP, was partially governed by this low level of potassium also.

Assuming that applications of potassium corrected potassium deficiency and provided adequate quantities of potassium for growth, applications of nitrogen and phosphorus along with potassium should result in additional growth. Phosphorus applied with potassium in some instances resulted in a greater increase in growth than potassium alone. However, such was not the case for other combinations of nutrients.

Table 10 shows the influence of the osmotic pressure of the applied solution on the growth of young cherry trees in treatments where potassium applications were adequate to correct potassium deficiency symptoms. As the osmotic pressure of the applied solution increased above two atmospheres growth was inversely proportional to the increase in osmotic pressure. From the data, an osmotic pressure value of approximately two atmospheres or less appears most desirable. Starter solutions having higher osmotic pressure values resulted in a reduction in growth. Probably early root growth was prevented due to plasmolysis.

One of the factors influencing the osmotic pressure of a solution is the salt concentration, which may be lowered by dilution with water. However, caution should be observed in applying this principle to the use of starter solutions. After the solutions have been applied to the soil the water may be depleted faster than the salts and result in a high salt concentration in the root zone. The effect of the osmotic pressure of an applied solution may be influenced by many factors such as the species of plant

TABLE 10

THE INFLUENCE OF THE OSMOTIC PRESSURE OF CERTAIN STARTER SOLUTIONS UPON GROWTH OF YOUNG SOUR CHERRY TREES

Solution number	Nutrients in solution	Osmotic* pressure	Terminal growth		Diameter increase	
			One gallon	Two gallons	One gallon	Two gallons
		atmos	cm	cm	mm	mm
3	K	1.62	160.8	172.8	5.99	4.65
6	PK	2.16	159.4	171.1	6.15	5.61
5	NK	3.60	133.2	132.5	4.76	4.32
7	NPK	5.40	124.1	121.2	5.00	4.01
8	NPK + TE	7.20	102.1	102.9	3.54	2.37

*Calculated by the formula: (Conductance in mhos times 10^{-5}) (0.36 times 10^{3}). (17) For additional osmotic pressure values see Appendix Table 17.

being grown, method of application, the water-holding and buffering capacity of the soil, rainfall, temperature, and humidity. The osmotic pressure of a solution may be affected by the particular salt, the amount of the salt, and the amount of water.

The reduction in growth of trees receiving solutions containing trace elements appeared to be due to boron toxicity (3). The boron content of leaves from trees, to which these solutions had been applied, was much higher than found in leaves of trees receiving the other treatments.

The application of starter solutions to fruit trees may prove beneficial in many cases. On soils low in potassium, a small amount of potassium may be applied as a water solution at planting time to provide enough potassium to prevent deficiency symptoms and result in increased growth of young sour cherry trees. Caution must be observed in the addition of trace elements, especially boron, to starter solutions.

Starter solutions may also prove beneficial when applied to young trees of many other kinds and varieties of fruits; the optimum rates and particular nutrients and carriers to be used would be dependent upon the kind of and variety of fruit tree and upon the composition of the soil.

SUMMARY

Nine different starter solutions were applied at two levels to young sour cherry trees at planting time.

The terminal growth and increase in trunk diameter of trees to which solutions had been applied was compared to that of check trees and to that of trees to which water without added nutrients was applied. The nutrient composition of leaf samples from each treatment was determined as well as the nutrient level of the soil in the root zone.

Applications of small quantities of certain fertilizer nutrients in water solution made at planting time did not result in injury to the trees. On a soil low in potassium, adequate potassium applied in water solution at planting time increased growth, averted potassium deficiency symptoms, and increased leaf potassium.

Boron, at the rates applied, was readily taken up by the trees and resulted in a decrease in growth.

The salt concentration or osmotic pressure of the solution applied to the trees affected their growth. In general, solutions having osmotic pressure values above two atmospheres resulted in a decrease in growth; the decrease in growth being inversely proportional to an increase in osmotic pressure.

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APPENDIX

APPENDIX TABLE 11

ALL-SOLUBLE FERTILIZERS FOR PLANT GROWING, STARTER SOLUTIONS, SIDEDRESSING APPLICATION IN WATER, AND FOR NUTRIENT SPRAYS

Trade name	Source	Analysis	Recommendations*		Additional nutrients*
		N P K	To soil	To Foliage (lbs/100 gals. water)	
Armour's All-Soluble Plant Food	Armour Fert. Works Chicago Hts., Ill.	15-52-9	6 lbs/100 gals. water	4 - 6	
Atlas Fertilizer	Atlas Fert. Emulsion 1 Drumm Street San Fransicso, Calif.	5.7-2.8-2.7	1 tbsp/ gal. water		Trace elements, vitamins and amino acids
Bio-Gro	Bioproducts Oregon Ltd., Warrenton, Ore.	10-5-5-	1 pt./40 gals. water	1pt./40 gals. water	Trace elements and organics
Bonro	Swift & Company Plant Food Division Hammond, Indiana	10-50-10	6 lbs/100 gals. water	4 - 6	
Chateliers Plant Food	Chateliers Labs. St. Petersburg, Fla.	8-8-20	1 lb/100 gals. water	2 - 3	Trace elements, vitamins, hormones
Dixco	Marion Chemical Co. Marion, Ohio	15-30-15	1 lb/50 gals. water	3	Trace elements
Dupont Soluble Plant Food		19-22-16			
Fertiline	H. D. Campbell Co. Rockville, Ill.	32-0-0			
Folium	Monsanto Chemical Co. St. Louis, Mo.	20-20-20			

APPENDIX TABLE 11 CONT.

Trade name	Source	Analysis N P K	Recommendations* To soil	To foliage (lbs/100 gals. water)	Additional* nutrients
Gro-Crop	Gro-Crop Sales Co. Box 863 Columbus, Miss.	5-10-5	1-2 tbsp/gal. water or as needed for particular crops & soil conditions		Trace elements
Haviland's Soluble Fertilizer #1	Haviland Products Co. 421 Ann Street	23-21-17		4 - 6	Vitamin B_1
#2	Grand Rapids, Mich.	16-26-13		4 - 6	Vitamin B_1
Hy-Gro	McCormick & Co., Inc. Baltimore 2, Md.	13-26-13	5 lbs/100 gals. water	5	Trace elements and hormones
Hyponex	Hydroponic Chem. Co. Copley, Ohio	7-6-19	1 lb/100 gals. water	2 - 3	Trace elements, vitamins, hormones
Instant Vigoro	Swift & Company	19-28-14			
Kap Co #1	Kelley Ag. Products McKeesport, Pa.	15-30-15	3 lbs/100 gals. water	2.5 indoor 4 - 6 outdoor	Trace elements
#2		20-10-20	3 lbs/100 gals. water	2.0 indoor 4.0 outdoor	Trace elements
#3		20-20-20	3 lbs/100 gals. water	2.0 indoor 4.0 outdoor	Trace elements
#4		20-0-30	3 lbs/100 gals. water	2.0 indoor 4.0 outdoor	Trace elements
Liqua-Vita	American Liquid Fertilizer Co. Marietta, Ohio	6-9-7	6 lbs/100 gals. water	6	Trace elements

APPENDIX TABLE 11 CONT.

Trade name	Source	Analysis	Recommdations*		Additional nutrients*
		N-P-K	To soil	To foliage (lbs/100 gals. water)	
Miracle-Gro	Stearns Nurseries Geneva, New York	15-30-15	1 tbsp/ gal. water	1 tbsp/ gal. water	Trace elements and vitamin B_1
Na-Churs	Na-Churs Plant Food Co. Marion, Ohio	5-10-5	1 pt.-1 qt./ 50 gals. water		Trace elements
Nu-Green	E. I. DuPont De Nemours & Company Wilmington, Delaware	44-0-0		4 - 6	
Nutri-Plant	Zircon Products Co. Box 5122 Indianapolis, Ind.	5-10-5	1-2 tbsp/ gal. water		Trace elements and vitamins
Nu Way	Nu Way Plant Food Co. Streator, Illinois	15-30-15	3 lbs/100 gals. water	2 - 3	Trace elements
Ortho-Gro	California Spray-Chemical Corp. Richmond, Calif.	10-5-5	1 pt.-1 qt./ 50 gals. water	1 pt.-1 qt./ 50 gals. water	Trace elements and organics
Plant Marvel	Plant Marvel Labs Chicago 28, Ill.	12.6-31.5-14.5	1 lb/250 gals. water	2	Trace elements and vitamins
Plant Prod	Plant Products Co. Blue Point, L.I., N.Y.	15-30-15	3 lbs/100 gals. water		

APPENDIX TABLE 11 CONT.

Trade name	Source	Analysis N P K	Recommendations* To soil	Recommendations* To foliage (lbs/100 gals. water)	Additional nutrients*
Plantabbs	Plantabbs Corp. Baltimore, Md.	11-15-20	400 tablets/ 100 gals. water		Vitamins
Ra-Pid-Gro	Rapid Gro Corp. Dansville, N. Y.	23-21-17		4 - 6	Trace elements and vitamins
Take-Hold	Victor Chem. Works Chicago, Illinois	10-52-17	6 lbs/100 gals. water	4 - 6	
Uran 32	Allied Chem. and Die Corp.	32-0-0			
V H P F	Miller Chem. & Fert. Co. Baltimore, Md.	6-25-15	12-18 lbs/ acre (in water)	6	Trace elements and hormones

*As listed by the manufacturers

APPENDIX TABLE 12

THE COMPOSITION AND pH OF VARIOUS STARTER SOLUTIONS APPLIED TO YOUNG SOUR CHERRY TREES

(Rates per 100 Gallons)

Solution number	Treatment designation	Ammonium nitrate	Phosphoric acid	Potassium chloride	pH
		pounds	pints	pounds	
1	N	3.81	-	-	7.2
2	P	-	0.85	-	2.4
3	K	-	-	2	7.5
4	NP	3.81	0.85	-	2.4
5	NK	3.81	-	2	7.2
6	PK	-	0.85	2	2.4
7	NPK	3.81	0.85	2	2.4
8*	NPK + TE	3.81	0.85	2	2.5
9*	TE	-	-	-	6.4

*Trace element mixture added. Composition of the mixture was:

12.55 pounds magnesium sulphate
0.53 pounds boric acid
0.44 pounds manganous sulphate
0.24 pounds copper sulphate
0.18 pounds ferrous sulphate
0.13 pounds zinc sulphate

APPENDIX TABLE 14

THE NUTRIENT LEVEL OF SOIL SAMPLES TAKEN FROM THE ROOT ZONE OF YOUNG SOUR CHERRY TREES TREATED WITH ONE GALLON OF VARIOUS STARTER SOLUTIONS

(Pounds per acre)

Solution number	Active test	Reserve test	
	Manganese	Manganese	Iron
	lbs/acre	lbs/acre	lbs/acre
1	2	N.D.	12
2	6	3	16
3	6	8	14
4	6	16	16
5	8	12	16
6	4	2	20
7	8	N.D.	14
8	14	8	18
9	12	18	14
Water	2	N.D.	32
Check	2	N.D.	32

N.D. - none detected

APPENDIX TABLE 17

THE OSMOTIC PRESSURE OF VARIOUS STARTER SOLUTIONS APPLIED TO YOUNG SOUR CHERRY TREES

(In Atmospheres)

Solution number	Treatment designation	Conductance* in mhos times 10^{-5}	Calculated** osmotic pressure
			atmospheres
1	N	700	2.52
2	P	250	0.90
3	K	450	1.62
4	NP	900	3.24
5	NK	1000	3.60
6	PK	600	2.16
7	NPK	1500	5.40
8	NPK + TE	2000	7.20
9	TE	675	2.43

*Conductance measured by means of a solu-bridge.

**Calculated by formula: (17)
(Conductance in mhos times 10^{-5}) (0.36 times 10^{3}).