Steaming and Fertilizers

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"I've always heard that I shouldn't add fertilizer to my soil before steaming because it will raise the soluble salt level!" This is the reply frequently given when a grower is asked why he doesn't add his superphosphate and limestone corrections when preparing the bed for planting.

We know that neither phosphorus nor calcium will move very rapidly or far from the point of application when applied to a soil. If a soil needs both of these elements the recommendation has been to apply them to the soil when it is being prepared for the next crop. In this way the particles of fertilizer will be thoroughly distributed through the mass of the soil by the rototilling or digging that is done. As the plant roots grow they will encounter the small particles of material and thus obtain the nutrient elements needed.

If superphosphate and limestone are needed and not added until after the crop is growing all kinds of problems arise. First, the crop suffers from deficiency for an extended period during the critical stages of its early growth. Second, surface applications are difficult to make with the crop in the bench and they are relatively ineffective in correcting the problem of low phosphorus or low pH.

To find out what happens when fertilizers are added to the soil mix and then steamed we conducted a small experiment. We took our regular greenhouse mix of 9 parts soil, 6 parts peat moss, 4 perlite and 2 sand and compared this with a 1-1-1 mix by volume of soil, peat moss and perlite.

To each of these soils we added fertilizers separately and in combination at the following rates:

20% superphosphate at 5#/100 square feet of area
Calcium limestone at 5#/100 square feet of area
10-10-10 at 2#/100 square feet of area.

The fertilizer treatments were:

A. Superphosphate alone
B. Calcium limestone alone
C. 10-10-10 alone
D. Superphosphate plus limestone
E. Superphosphate plus 10-10-10
F. Limestone plus 10-10-10
G. Superphosphate plus limestone plus 10-10-10.

The treatments used would give us some idea of what each fertilizer amendment would do to the total soluble salt level, the pH, and phosphorus content. To find out when the effect was produced we soil tested on this schedule:

I—Basic soil mix with no fertilizer added and not steamed

II.—Basic soil mix fertilized but not steamed

III.—Basic soil mix fertilized and steamed.

The results obtained are presented in Tables 1 and 2. Depending on the soil mixture used there were some differences in the results obtained. The 9-6-4-2 mixture has a greater amount of basic soil present. This larger volume of soil would provide more soil colloids for reactions to take place and thus tie-up certain mineral elements such as phosphorus. There would also be a greater buffering capacity that would resist large changes in pH from occurring.

Examination of Table 1 shows that regardless of the fertilizer amendment added there was an increase in the total soluble salt content of both the 9-6-4-2 and 1-1-1 soil mixture, when the soil *was not steamed.* This would be expected since all of the materials supply some type of salts. In the 9-6-4-2 mixture the addition of the materials caused a reduction in the pH of the media except where limestone alone and limestone plus 10-10-10 were added. Evidently the alkalizing effect of the limestone was greater than the acidifying effect of the 10-10-10.

Phosphorus levels increased except where limestone and 10-10-10 were combined.

After these mixtures were steamed the soil tests showed a significant change in the content of the soil. Steaming caused approximately a 50% reduction in available phosphorus in all of the treatments except the limestone plus 10-10-10. Here available phosphorus went from a trace to 1 ppm. Generally however, steaming caused a tieing-up of phosphorus so that it was less available as far as soil tests are concerned.

With the 9-6-4-2 all treatments showed *a reduction* in the total soluble salt content of the soil from the level that existed in the same soil before steaming. The decrease in salts ranged from 10 to 90% depending on the amendments used.

In every case steaming resulted in *an increase* in the pH of the soil over that which existed before steaming but after adding fertilizers. With some amendments particularly limestone the pH after steaming was greatly increased over that of the original soil mix before adding amendments.

1-1-1 Mixture

The results obtained with 1-1-1 mixture were somewhat different than with the 9-6-4-2 especially after the amended soil mix was steamed.

With amendments added and the soil mix *not steamed* the phosphorus levels and total soluble salts were the same as for the 9-6-4-2.

All amendments caused an increase in the levels over those which existed in the recommended mix with the exception of the limestone plus 10-10-10.

The pH values decreased except where limestone was added. Since the original pH of the 1-1-1 mixture was 5.0 the decrease in pH would be significance only for a few days. As soon as soil biological activity began the limestone reaction would cause the pH to rise.

When the mixes were steamed there was a decrease in the phosphorus content of the soils. Again the exception was the limestone and 10-10-10 treatment. The value increased from a trace to 1 ppm.

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Table 1. Summarization table of the effect of steam sterilization on available phosphorus, total soluble salts, and pH in a 9-6-4-2 and 1-1-1 soil mix amended with superphosphate, calcium limestone and 10-10-10 singularly or in combinations.

	9-6-4-2						1-1-1					
	Not Steamed			Steamed			Not Steamed			Steamed		
Fertilizer Amendment	Phos.	T.S.S.	pH	Phos.	T.S.S.	pH	Phos.	T.S.S.	pH	Phos.	T.S.S.	pH
Superphos.	+	+	—	—	—	+	+	+	—	—	—	+
Limestone	0	+	+	0	—	+	0	+	+	0	—	+
10-10-10	+	+	—	—	—	+	+	+	—	0	—	+
Super. + lime.	+	+	—	—	—	+	+	+	+	—	—	+
Super. + 10-10-10	+	+	—	—	—	+	+	+	—	—	+	+
Lime + 10-10-10	0	+	+	+	—	+	0	+	+	+	+	+
Super. + Lime + 10-10-10	+	+	—	—	—	+	+	+	+	—	+	+

\+ Increase
— Decrease
0 No change

The effect of steaming on the total soluble salt content was variable. Salts decreased where superphosphate, limestone and 10-10-10 were added alone and where superphosphate plus limestone were added. In the three treatments where 10-10-10 was combined with the other amendments the total soluble salts increased. This increase ranged from 4% for superphosphate plus 10-10-10 to 30% for the combination of three materials (Table 2).

This increase in salts may be due to a reduced amount of soil colloids in the 1-1-1 mixture as opposed to the 9-6-4-2. This would allow more of the elements to remain available and thus add to the total salt environment.

The effect of steaming was to cause an increase in the pH of the soil regardless of the amendment added. In many cases the change in pH was 1.0 units or more. This greater increase would reflect the reduced buffering capacity of the 1:1:1 mix.

SUMMARY

As a summarization of this report we can see that soil mixture has an effect on the magnitude of the changes that take place. With the 9-6-4-2 that has 43% by volume basic soil there is a greater resistance to changes caused by steaming in salt content and pH depending on the amendments added.

The addition of amendments to the 9-6-4-2 before steaming always resulted in an increase in the total soluble salt content.

Generally pH of the media was decreased except where limestone alone and limestone plus 10-10-10 was used.

When amendments were added and *the soil steamed,* total soluble salt content was reduced and *pH of the soil was increased.*

When the soil mixture contained only 30% basic soil by volume the results of adding fertilizer amendments were the same as for the 9-6-4-2. Total soluble salts increased and pH generally decreased. With amendments added and the soil steamed, in four treatments the total soluble salt content *decreased* over that which existed when the soil was not steamed. In three treatments, particularly where

Table 2. Effect of steam sterilization on available phosphorus, total soluble salts and pH of two soil mixtures amended with various fertilizer materials.

			9-6-4-2[a] Fertilizer amendments						
	Orig. Soil Test	Not Steamed or Steamed	Superphosphate	Limestone	10-10-10	Super + Lime	Super + 10-10-10	Lime + 10-10-10	Super + Lime + 10-10-10
Phos.	(trace)	N.S.	10	trace	1	4	5	trace	4
		S.	5	trace	trace	2	2	1	2
T.S.S.	(25)	N.S.	77	44	89	100	140	112	135
		S.	67	29	52	72	101	58	100
pH	(6.6)	N.S.	6.4	6.9	6.4	6.5	6.3	6.9	6.4
		S.	6.6	7.3	6.9	7.1	6.7	7.3	6.9
			1-1-1[b]						
Phos.	(trace)	N.S.	3	trace	1	6	6	trace	5
		S.	trace	trace	1	2	3	1	2
T.S.S.	(20)	N.S.	158	42	75	98	120	58	101
		S.	87	32	57	94	125	80	150
pH	(5.0)	N.S.	4.7	5.6	4.6	5.4	4.6	5.4	5.2
		S.	5.8	6.5	5.8	6.4	5.4	6.1	6.2

[a]—9 soil, 6 peat moss, 4 perlite, 2 sand by volume.
[b]—1 soil, 1 peat moss, 1 perlite by volume.
Phos.—PPM—modified Spurway soil test.
T.S.S.—MHOS in 1:2 soil water extract

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10-10-10 was combined with other amendments the soluble salt content *increased.* The pH of the 1-1-1 *mixture* was always *increased* after steaming regardless of the amendment added.

From these results it may be seen that steaming a growing media that contains a high percentage of basic soil to which amendments have been added does not increase the total soluble salt content of the soil. Where a media is used that has only ⅓ or less basic soil, steaming may cause an increase in soluble salts or a decrease depending on what materials are used and how heavily the soil is "loaded" with fertilizer amendments.