CHAPTER 2

THE EFFECT OF SOIL MODIFICATION ON SOIL TEST RESULTS

Methods and Materials

Soil samples were taken from the Soil Modification Plots, which were described in Chapter 1. In May, 1973, twenty-eight of the soil mixtures were sampled at a depth of 0 - 5 cm in both compacted and non-compacted subplots (Table 12). Using the laboratory procedures described in Chapter 1, soil fertility values were determined for each of the samples to study the effects of types of soil amendments, level of soil modification, and compaction on soil test results. Zimmerman (1969) determined soil fertility values for the same twenty-eight mixtures in 1967. Due to the wide range of bulk densities of these mixtures, weighed rather than scooped samples were used for all determinations. Differences in assumed and actual weight taken by a 5.0 g scoop were measured by weighing scooped samples of all twenty-eight mixtures. Analysis of variance for soil test results were computed with sources of variation being soil mixtures and compaction treatments.

Results and Discussion

The significance of F-ratios for the analysis of variance of soil test results for twenty-eight mixtures is indicated in Table 39.

Several factors should be considered in comparing soil fertility values for different soil mixtures. Differences in the chemical composition and fertility levels of the individual materials used in the soil mixtures occurred, and were reported by Zimmerman (1969). Soil

Table 12. Mixtures from the Soil Modification Plots sampled for soil testing.

Sand	Soil	Peat	Amend-ment	Sand	Soil	Peat	Amend-ment
percent by volume				percent by volume			
40 Q	50	10	---	60 C	20	20	---
50 Q	40	10	---	66-2/3 C	16-2/3	16-2/3	---
60 Q	30	10	---	---	60	10	30 USS
80 Q	30	10	---	---	50	10	40 USS
40 Q	40	20	---	---	30	10	60 USS
50 Q	30	20	---	20 Q	10	10	60 USS
60 Q	20	20	---	20 Q	30	20	30 USS
80 Q	---	20	---	---	60	10	30 W
---	80	20	---	20 Q	30	20	30 W
40 M	40	20	---	---	50	10	40 P
50 M	30	20	---	40 Q	10	10	40 P
60 M	20	20	---	---	50	10	40 T
66-2/3 M	16-2/3	16-2/3	--	40 Q	10	10	40 T
40 C	40	20	---				
50 C	30	20	---				

Q Coarse sand

M Mortar sand

C Concrete sand

USS USS slag

W Wunderley slag

P Perl-lome

T Turface

mixtures were made on a volume basis; however, due to differences in the bulk densities of the individual materials, the amount of soil by weight in each mixture may vary from the amount by volume. The rate of nutrient movement through the soil profile as well as the amount of P and/or K fixed probably varied among soil mixtures. Finally, turfgrass growth, and therefore nutrient extraction by the turfgrass plant, may have varied among soil mixtures.

Peat Content. The effect of peat content on soil fertility values was measured by comparing soil mixtures containing 10 and 20 percent peat by volume. Comparisons were made for increased peat content at the expense of sand or soil. Soil fertility values are shown in Table 13.

Increasing peat content at the expense of soil decreased pH and pH-B in both 40 and 50 percent sand mixtures, while having no effect on either value in 60 and 80 percent sand mixtures. Increasing peat content at the expense of sand decreased pH and pH-B in 40 percent soil mixtures, while not affecting either value in 30 percent soil mixtures.

No consistent trend developed for P values. In the 40 and 50 percent sand mixtures and 30 and 40 percent soil mixtures, increasing peat content had no effect on P values. However, increasing peat content increased P values in the 60 percent sand mixtures and decreased values in the 80 percent sand mixtures. K values were not affected by peat content. Mg values, Ca values, and CEC increased with increased peat content, although the increases in Mg values were not always significant.

Table 13. The effect of peat content on soil fertility values.

Percent by volume			pH	pHB	P	K	Mg	Ca	CEC	K	Mg	Ca
Coarse sand	Soil	Peat										
					kg/ha	meq/100 g				% saturation		
40	50	10	6.8a-c*	6.9a	141e-g	0.14a-c	1.6f-i	6.8b-d	9.9cd	1.4ab	16.5bc	69.2ab
40	40	20	6.5e	6.8b	153c-g	0.09c-g	1.9a-e	7.7a	12.0a	0.8f-h	16.2bc	64.8c-e
50	40	10	6.8a	6.9a	168b-e	0.09d-g	1.4hi	5.7fg	8.7e	1.0c-g	17.3ab	66.3b-d
50	30	20	6.6e	6.8b	158c-g	0.09c-g	1.8b-g	7.1a-c	11.4ab	0.8e-h	16.4bc	62.3d-g
60	30	10	6.7a-e	6.8b	146d-g	0.10c-g	1.5g-i	5.5fg	9.2de	1.1b-e	17.0ab	60.0fg
60	20	20	6.6b-e	6.8b	203a	0.08fg	1.7d-h	6.6c-e	10.4c	0.7gh	16.8ab	63.3c-f
80	10	10	6.8a-d	6.8b	189ab	0.08e-g	1.4i	5.0g	8.4e	0.9d-h	16.7a-c	58.7g
80	0	20	6.8a-d	6.8b	136g	0.06g	1.6f-i	6.2d-f	10.0cd	0.6h	16.3bc	62.7d-g

* Means in each column not followed by the same letter are significantly different at the 5 percent level of probability.

Percent K saturation decreased with increased peat content in all mixtures; however, differences were significant only in the 40 and 60 percent sand mixtures. Although percent Mg saturation decreased with increased peat content in all mixtures, the difference was never significant. Percent Ca saturation was only significantly affected in the 40 percent sand mixture, where values decreased with increased peat content.

Type and Amount of Sand. The effect of the type and the amount of sand on soil fertility values was measured by comparing soil mixtures containing 40, 50, 60, and 80 percent coarse sand and 40, 50, 60, and 66-2/3 percent mortar or concrete sands. Soil test results are shown in Table 14.

The amount and the type of sand in the soil mixtures had little effect on pH, with all values falling in the range of 6.5-6.7. Significant differences in pH with increasing sand content occurred in only two cases. The pH was higher in the mixture with 0 percent sand than in the 40 percent mortar and sand mixture, and was higher in the 80 percent coarse sand mixture than in the 40 and 50 percent coarse sand mixtures. Significant differences in pH for mixtures containing the same amount of different types of sand occurred only once, being higher in the 40 percent concrete sand mixture than in the 40 percent mortar sand mixture. No differences occurred in pH-B for either the amount or the type of sand.

The effect of the amount of sand in the soil mixtures on P values was inconsistent. However, with the exception of the 80 percent coarse sand mixture, mixtures with 60 percent or more sand had higher

Table 14. The effect of type and amount of sand on soil fertility values.

Percent by Volume			pH	pHB	P
Sand	Soil	Peat			kg/ha
Coarse					
40	40	20	6.5 ef*	6.8 a	153 cdefgh
50	30	20	6.5 ef	6.8 a	158 cedfg
60	20	20	6.6 bcdef	6.8 a	203 a
80	0	20	6.7 abcd	6.8 a	136 gh
Mortar					
40	40	20	6.5 f	6.8 a	139 fgh
50	30	20	6.6 def	6.8 a	134 gh
60	20	20	6.6 cdef	6.8 a	160 cdefg
66-2/3	16-2/3	16-2/3	6.6 bcdef	6.8 a	181 abc
Concrete					
40	40	20	6.7 abcde	6.8 a	142 efgh
50	30	20	6.6 bcdef	6.8 a	127 h
60	20	20	6.5 ef	6.8 a	174 bcd
66-2/3	16-2/3	16-2/3	6.6 bcdef	6.8 a	166 bcdef
None	80	20	6.7 abcde	6.8 a	138 fgh

* Means in each column not followed by the same letter are significantly different at the 5 percent level of probability.

Table 14 (Continued) The effect of type and amount of sand on soil fertility values.

K	Mg	Ca	CEC	K	Mg	Ca
meq/100 g				% saturation		
0.09 efghi	1.9 cdefg	7.7 c	12.0 c	0.8 fgh	16.2 bc	64.8 cde
0.09 efghi	1.8 defgh	7.1 cde	11.4 cd	0.8 efgh	16.4 bc	62.3 de
0.07 hi	1.7 fgh	6.6 ef	10.4 e	0.7 gh	16.8 ab	63.3 cde
0.06 i	1.6 h	6.2 f	10.0 e	0.6 h	16.3 bc	62.7 de
0.12 cdef	1.8 defgh	7.8 c	12.0 c	1.0 cdefg	15.7 bc	65.2 cd
0.13 cdef	1.9 defgh	7.4 cde	11.6 c	1.1 bcd	16.5 bc	63.7 cde
0.11 cdefgh	1.7 efgh	6.6 ef	10.5 de	1.1 bcdef	16.9 ab	62.9 cde
0.11 cdefghi	1.9 defgh	6.2 f	10.3 e	1.0 cdef	18.4 a	61.2 e
0.16 bc	2.2 abc	8.9 b	13.4 b	1.2 bcd	17.1 ab	66.7 abc
0.15 cd	2.3 ab	8.9 b	13.4 b	1.1 bcde	17.1 ab	66.8 abc
0.12 cdefg	2.0 bcde	6.5 cd	12.1 c	1.0 defg	17.1 ab	62.4 de
0.11 defgh	1.9 cdefgh	7.8 c	11.8 c	1.0 defg	16.4 bc	65.8 bcd
0.20 ab	2.2 abc	10.6 a	15.1 a	1.4 abc	14.9 c	70.4 a

P levels than mixtures with less than 60 percent sand, although the differences were not always significant. A combination of greater P fixation in nonavailable forms with increasing amounts of soil in the mixtures and greater movement of P with increasing sand content may help to explain these results. At the same level of modification, P values were generally higher for coarse sand mixtures than for mortar and concrete sand mixtures.

Increasing sand content resulted in a trend of decreasing CEC. Although significant differences did not always occur between each increase in sand content, significant decreases did occur over the entire range of sand contents. CEC was significantly greater for the 0 percent sand mixture than for the 40 and 50 percent sand mixtures, which were significantly greater than the 60, 66-2/3, and 80 percent sand mixtures. CEC was greater for concrete sand mixtures than for coarse and mortar sand mixtures.

Although K levels generally decreased with increasing sand content, the primary decrease in K occurred in increasing sand from 0 to 40 percent. Significant differences in K for mixtures with 40 percent or more sand occurred only once, with levels being higher in the 40 percent than in the 66-2/3 percent concrete sand mixture. At the same level of modification, K levels were generally highest in the concrete sand mixtures and lowest in the coarse sand mixtures.

With increasing sand content, Mg levels either decreased or were not significantly affected. The effect of increasing sand content on Ca values was greater. Ca values were significantly higher in the 0 percent sand mixture than in the 40 percent sand mixtures, with a general decrease in Ca occurring with additional increases in sand. For mixtures with the same amount of sand, Mg and Ca values were higher in mixtures containing concrete sand, although differences in Mg values were not always significant.

Increasing sand content significantly affected percent K saturation in only one case, being higher in the mixture containing 0 percent sand than in the all mixtures containing coarse sand. Percent K saturation was also lower in the coarse sand mixtures than in mortar and concrete sand mixtures, although differences were not always significant.

The effect of increasing sand content on percent Mg saturation was not great. Values were lowest in the 0 percent sand mixture, and the 80 percent mortar sand mixture was significantly higher than both 40 and 50 percent mortar sand mixtures. No significant differences in percent Mg saturation occurred among types of sand at the same level of modification.

Percent Ca saturation had a decreasing, although somewhat inconsistent, trend with increasing sand content. In all cases, percent Ca saturation was significantly higher in the 0 percent sand mixture than in mixtures with 60 percent or more sand. Significant differences in percent Ca saturation among types of sand at the same level of modification occurred only once. Values were greater for concrete sand than for coarse sand in mixtures containing 50 percent sand.

Types of Amendments. The effect of different amendments on soil fertility values was determined by comparing mixtures containing 40 percent coarse sand, USS slag, Perl-lome, or Turface, and 60 percent coarse sand or USS slag. Soil test results are shown in Table 15.

The pH values for soil mixtures containing 40 and 60 percent USS slag were at least 1.0 pH unit higher than all other mixtures, which were not significantly different. The pH-B was higher for USS slag than for coarse sand in the 60 percent mixtures, and in the order of USS slag>coarse sand = Perl-lome>Turface in the 40 percent mixtures.

P values were much higher in the 60 percent coarse sand mixture than in the 60 percent USS slag mixture. Levels in the 40 percent mixtures for P were in the order coarse sand>Perl-lome = Turface>USS slag. P fixation in the form of insoluble calcium phosphates at the high pH occurring in the USS slag mixture probably caused the low levels of available P.

Ranking of CEC for the 40 percent mixtures was USS slag = Turface>Perl-lome>coarse sand. CEC for the 60 percent USS slag mixture was nearly double that of the 60 percent coarse sand mixture. Zimmerman (1969) attributed the relatively high CEC of the USS slag mixtures to the laboratory extraction of free complex Ca compounds as exchangeable Ca.

K, Mg, and Ca values were greater in the 60 percent USS slag mixture than in the 60 percent coarse sand mixture. Higher values in the USS slag may have been due to higher amounts in the original materials and to greater adsorption of applied nutrients due to greater CEC. Ranking of K in the 40 percent mixtures was Turface>USS slag>Perl-lome>coarse sand. Mg values for the 40 percent mixtures were ranked Turface>Perl-lome = USS slag>coarse sand. Ranking of Ca values for the 40 percent mixtures was USS slag>Turface = Perl-lome>coarse sand. These

Table 15. The effect of different amendments on soil fertility values.

Amendment	Percent by volume: Amend-ment	Soil	Peat	pH	pHB	P	K	Mg	Ca	CEC	K	Mg	Ca
						kg/ha	meq/100 g				% saturation		
Coarse sand	40	50	10	6.8 b*	6.9 b	141 a	0.14e	1.6 c	6.8 c	9.9 c	1.4 fg	16.5 b	69.2 c
USS slag	40	50	10	7.8 a	7.0 a	76 c	0.33 c	1.9 b	15.0 a	17.3 a	1.9 cde	11.0 d	86.9 a
Perl-lome	40	50	10	6.8 b	6.9 b	109 b	0.24 d	1.9 b	10.5 b	14.1 b	1.7 def	14.0 c	74.8 b
Turface	40	50	10	6.7 b	6.8 c	109 b	0.60 a	3.8 a	11.2 b	17.7 a	3.4 a	21.9 a	63.2 d
Coarse sand	60	30	10	6.7 b	6.8 c	146 a	0.10 e	1.5 c	5.5 d	9.2 c	1.1 g	17.0 b	60.0 d
USS slag	60	30	10	7.8 a	7.0 a	59 c	0.42 b	2.0 b	15.0 a	17.4 a	2.4 b	11.5 d	86.0 a

* Means in each column not followed by the same letter are significantly different at the 5 percent level of probability.

results are probably due to a combination of the original fertility values of these mixtures, differences in CEC among mixtures, and different rates of nutrient movement through the different mixtures.

Percent saturations of the cations for the 60 percent USS slag mixture was higher for K and Ca and lower for Mg than for the 60 percent coarse sand mixture. Ranking for the 40 percent mixtures for percent K saturation was Turface>USS slag>coarse sand, with Perl-lome not statistically different from USS slag or coarse sand. Percent Mg saturation values were ranked Turface>coarse sand>Perl-lome>USS slag. Ranking for percent Ca saturation was USS slag>Perl-lome>coarse sand> Turface.

USS Slag Versus Wunderley Slag. The effect of USS slag versus Wunderley slag on soil fertility values was determined by comparing mixtures containing 30 percent USS slag or Wunderley slag, 60 percent soil, and 10 percent peat, and by comparing mixtures containing 30 percent USS slag or Wunderley slag, 20 percent coarse sand, 30 percent soil, and 20 percent peat. Soil test results are shown in Table 16.

The pH for mixtures containing 0 percent coarse sand were not significantly different; however, in the 20 percent coarse sand mixtures, a significantly higher pH occurred in the mixture containing USS slag. The pH-B was not affected.

In both the 0 and 20 percent coarse sand mixtures, P values were higher in the mixtures containing USS slag. Greater P fixation may have occurred in Wunderley slag mixtures.

Table 16. The effect of USS and Wunderley slags on soil fertility values.

Percent by Volume					pH	pHB	P	K	Mg	Ca	CEC	K	Mg	Ca
Slag		Coarse sand	Soil	Peat										
							kg/ha	meq/100 g				% saturation		
30	USS	--	60	10	7.5b*	7.0a	80a	0.31b	1.8c	14.6a	16.8b	1.8a	11.0c	87.0a
30	W	--	60	10	7.6b	7.0a	48b	0.35ab	2.5b	14.3a	17.2ab	2.0a	14.8b	83.2ab
30	USS	20	30	20	7.8a	7.0a	80a	0.37a	2.1c	15.0a	17.5ab	2.0a	12.1c	86.9a
30	W	20	30	20	7.4b	7.0a	44b	0.34ab	3.0a	14.4a	17.8a	1.9a	17.2a	80.8b

* Means in each column not followed by the same letter are significantly different at the 5 percent level of probability.

CEC, K, and Ca were not affected by the type of slag. Mg was higher in mixtures containing Wunderley slag, probably due to the higher initial Mg levels in the Wunderley slag material.

Percent K saturation was not affected by the type of slag. Although not significantly different in the 0 percent coarse sand mixtures, the 20 percent coarse sand mixture containing USS slag had a significantly higher percent Ca saturation. Percent Mg saturation was higher in mixtures containing Wunderley slag.

Amount of USS Slag. The effect of increasing amounts of USS slag on soil fertility was determined by comparing mixtures containing 30, 40, and 60 percent USS slag. Soil test results are shown in Table 17.

The effect of increasing USS slag content from 30 to 60 percent on soil fertility was not great. The pH was higher in the 40 and 60 percent USS slag mixtures than in the 30 percent mixture, with no difference in pH-B.

A decreasing, but nonsignificant, trend with increasing USS slag content occurred for P, indicating increasing P fixation with increasing USS slag content.

CEC, Mg, Ca, percent Mg saturation, and percent Ca saturation were not significantly affected by increasing USS slag content from 30 to 60 percent. K and percent K saturation were higher in the 60 percent USS slag mixture than the mixtures containing 30 and 40 percent USS slag.

Table 17. The effect of increasing amounts of USS slag on soil fertility values.

Percent by volume			pH	pHB	P	K	Mg	Ca	CEC	K	Mg	Ca
USS slag	Soil	Peat										
					kg/ha	meq/100 g				% saturation		
30	60	10	7.5 b*	7.0 a	80 a	0.31 b	1.8 a	14.6 a	16.8 a	1.8 b	11.0 a	87.0
40	50	10	7.8 a	7.0 a	76 a	0.33 b	1.9 a	15.0 a	17.3 a	1.9 b	11.0 a	86.9 a
60	30	10	7.8 a	7.0 a	59 a	0.42 a	2.0 a	15.0 a	17.4 a	2.4 a	11.5 a	86.0 a

* Means in each column not followed by the same letter are significantly different at the 5 percent level of probability.

The Effect of Substitution of Amendments for Coarse Sand. The effect of substituting amendments for coarse sand on soil fertility values was determined by comparing a mixture containing 80 percent coarse sand with mixtures for which Perl-lome or Turface were substituted for 1/2 of the sand and USS slag was substituted for 3/4 of the sand. Soil test results are shown in Table 18.

Substitution of USS slag for coarse sand resulted in a much higher pH and a higher pH-B, while substitution of Turface or Perl-lome for coarse sand had no significant effect on pH or on pH-B.

Subsitution of Perl-lome for coarse sand resulted in higher P, but the difference was nonsignificant. Substitution of Turface and USS slag for coarse sand resulted in significant decreases in P. Zimmerman (1969) attributed high P values in the mixture containing Perl-lome to a greater percent by weight of soil in the mixture than in the other mixtures, and the low values in the mixture containing USS slag to P fixation and incomplete P extraction.

Substitution of amendments for coarse sand resulted in increased CEC in all cases. The greatest increase was caused by USS slag. Turface caused a greater increase in CEC than did Perl-lome.

Higher levels of the three cations measured generally resulted from the substitution of amendments for coarse sand. Although substituting Perl-lome for coarse sand did not significantly increase K, substituting Turface and USS slag for coarse sand resulted in large increases in K. A similar trend occurred for Mg, with the greatest increase resulting from the substitution of Turface for coarse sand. All amendments increased Ca, with the greatest increase

Table 18. The effect of substituting amendments for coarse sand.

Percent by Volume				pH	pHB	P	K	Mg	Ca	CEC	K	Mg	Ca
Amend-ment	Coarse sand	Soil	Peat										
						kg/ha	meq/100 g				% saturation		
--	80	10	10	6.8 b*	6.8 b	189 a	0.08 b	1.4 c	5.0 d	8.4 d	0.9 c	16.7 b	58.9 b
40 P	40	10	10	6.6 b	6.8 b	206 a	0.11 b	1.6 c	5.9 c	9.7 c	1.1 c	17.4 b	60.9 b
40 T	40	10	10	6.8 b	6.8 b	110 b	0.35 a	3.2 a	7.8 b	13.6 b	2.6 a	24.3 a	58.0 b
60 USS	20	10	10	7.8 a	7.0 a	80 c	0.37 a	2.1 b	15.0 a	17.5 a	2.0 b	12.1 c	85.8 a

* Means in each column not followed by the same letter are significantly different at the 5 percent level of probability.

P Perl-lome

T Turfacd

USS USS slag

resulting from the substitution of USS slag for coarse sand. Increases in Ca were significantly greater when Turface versus Perl-lome was substituted for coarse sand.

Percent saturation of the cations followed a trend similar to the individual values. Substitution of Turface and USS slag for coarse sand resulted in significant increases in percent K saturation, with the greater increase resulting from Turface. Substitution of Turface and USS slag for coarse sand resulted in increases and decreases respectively in percent Mg saturation. Only the substitution of USS slag for coarse sand resulted in significant differences in percent Ca saturation, with values being increased.

Compaction and Aerification. Neither compaction nor aerification had much effect on soil fertility. When all twenty-eight mixtures were considered (Table 19), compaction significantly affected only K, Mg, and their respective percent saturations. Compaction increased K and percent K saturation and decreased Mg and percent Mg saturation. When the five mixtures representing different levels of modification with coarse sand (Chapter 1) were considered (Table 20), only Mg and percent Mg saturation were significantly affected by compaction with both decreasing. Aerification of the same five mixtures (Table 20), increased K, Mg, and percent Mg saturation.

Although significant compaction x soil mixture and aerification x soil mixture interactions occurred for several soil test values, the effects were not generally of a great magnitude and were rather inconsistent, and thus not easily interpretable.

Table 19. The effect of compaction on soil test results for twenty-eight soil mixtures representing different types of amendments and levels of modification.

Treatment	Soil Test Results									
	pH	pHB	P	K	Mg	Ca	CEC	K	Mg	Ca
			kg/ha	meq/100 g				% saturation		
Noncompacted	6.9 a*	6.9 a	134 a	0.19 b	2.1 a	9.3 a	13.2 a	1.3 b	16.8 a	69.2 a
Compacted	6.9 a	6.9 a	128 a	0.21 a	1.9 b	9.3 a	13.0 a	1.5 a	15.4 b	69.7 a

* Means in each column not followed by the same letter are significantly different at the 5 percent level of probability.

Table 20. The effect of compaction and aerification on soil test results for five soil mixtures representing different levels of modification with coarse sand.

	Soil Test Results									
Treatment	pH	pHB	P	K	Mg	Ca	CEC	K	Mg	Ca
			kg/ha	meq/100 g				% saturation		
Noncompacted	6.8 a*	6.8 a	87 a	0.12 a	1.9 a	7.6 a	11.1 a	1.0 a	17.2 a	68.8 a
Compacted	6.8 a	6.8 a	88 a	0.13 a	1.8 b	7.8 a	11.3 a	1.1 a	16.q b	68.9 a
Nonaerified	6.8 b*	6.8 a	88 a	0.11 b	1.7 b	7.6 a	11.1 a	10.0 a	16.0 b	68.0 a
Aerified	6.9 a	6.9 a	87 a	0.13 a	1.9 a	7.8 a	11.3 a	1.1 a	17.4 a	69.6 a

* Compaction treatment means or aerification treatment means in each column not followed by the same letter are significantly different at the 5 percent level of probability.

Harper (1952) reported that P penetration was significantly increased by aerification when superphosphate was applied at the time of aerification. Fertilization of the Soil Modification Plots did not coincide with aerification, and the differences in fertilization timing seem to be a reasonable explanation for the differences in results.

Actual Versus Assumed Laboratory Weights of Soil Mixtures. To determine errors introduced into the soil testing procedure by using assumed weights for soil samples, all twenty-eight mixtures were sampled with a scoop which took an assumed weight of 5.0 g. The scooped material was then weighed.

Actual weights (Table 21) for these mixtures were as much as 26 percent lower and 10 percent higher than the assumed weight of 5.0 g. The presence of slag, Perl-lome, or Turface decreased weights and sand increased weights. Soil testing programs which report soil test results on a soil weight basis could therefore be introducing error into reported soil test values. Lime and fertilizer recommendations based on these values could also be inaccurate. However, using The Pennsylvania State University system, P and K fertilizer recommendations are not affected by differences in assumed versus actual soil weight due to offsetting errors in the system. P is reported on an acre basis, which is in effect a volume unit. Although the actual weight of the scooped sample may differ from the assumed weight, the weight of soil per acre would also differ by the same factor from the assumed weight of 2,000,000 lb/A. Therefore, reported values are accurate on an acre basis despite differences in actual versus assumed soil weights, and P

Table 21. Actual weight of different mixtures taken by a 5.0-gram scoop.

Sand	Soil	Peat	Amend-ment	Actual weight
———	percent by volume	———		g
40 Q	50	10		5.12
50 Q	40	10		5.30
60 Q	30	10		5.20
80 Q	10	10		5.40
40 Q	40	20		5.00
50 Q	30	20		5.34
60 Q	20	20		5.28
80 Q		20		5.50
	80	20		4.42
40 M	40	20		5.06
50 M	30	20		5.04
60 M	20	20		5.26
66-2/3 M	16-2/3	16-2/3		5.32
40 C	40	20		4.79
50 C	30	20		4.88
60 C	20	20		5.08
66-2/3 C	16-2/3	16-2/3		5.06
	60	10	30 USS	4.42
	50	10	40 USS	4.37
	30	10	60 USS	4.42
20 Q	10	10	60 USS	4.61
20 Q	30	20	30 USS	4.74
	60	10	30 W	4.30
20 Q	30	20	30 W	4.54
	50	10	40 P	3.88
40 Q	10	10	40 P	4.80
	50	10	40 T	3.70
40 Q	10	10	40 T	4.38

Q Coarse sand
M Mortar sand
C Concrete sand
USS USS slag
W Wunderley slag
P Perl-lome
T Turface

fertilizer recommendations would not be affected. Similar reasoning holds true for lime recommendations based on pH and pH-B.

K values are reported by The Pennsylvania State University on a weight basis, meq K/100 g soil, and would therefore be inaccurate if the actual soil weight varied from the assumed weight. However, K fertilizer recommendations are based on K saturation rather than on actual values. Since the relative amounts of the cations would not change with the weight of the soil sample being tested, the percent K saturation would not change, and K fertilizer recommendations therefore would not be affected by differences in assumed versus actual soil weights.

Summary and Conclusions

Twenty-eight mixtures from the Soil Modification Plots representing different levels of soil modification with different amendments were sampled. Increasing peat content in the mixtures generally increased CEC, Ca, and Mg and lowered pH values. Percent K saturation values decreased with increasing peat content.

Nutrient levels tended to decrease with sand additions. CEC, Ca, and K values decreased with increasing sand content. Coarse and mortar sand additions also decreased Mg values. Although sand additions significantly affected P levels, results were inconsistent. Soil fertility values tended to be higher in concrete sand mixtures than in coarse or mortar sand mixtures.

The addition of slag to soil mixtures increased pH, K, Mg, Ca, percent Ca saturation, and CEC. P values decreased with additions of slag, probably due to fixation of P in nonavailable forms under the existing high pH and Ca conditions. Wunderley slag decreased P values and increased Mg values more than USS slag.

Turface additions generally lowered P and increased K, Mg, Ca, CEC, and percents K and Mg saturation.

Inclusion of Perl-lome in soil mixtures generally increased K, Mg, Ca, and CEC. However, increases in these values were not as great as those for Turface.

A combination of the following factors may have resulted in soil fertility values differences among the various mixtures:

(1) Differences among the soil amendments in inherent fertility

(2) Differences in cation exchange capacity of the amendments, resulting in different amounts of applied nutrients adsorbed

(3) Differences in the bulk density of the amendments, resulting in different weight percentages of soil in the mixtures

(4) Differences in the effect of the amendments on infiltration rates, resulting in different amounts of nutrients leached

(5) Differences in the effect of the amendments on soil physical properties which could influence turfgrass growth, resulting in different amounts of nutrients removed by the turfgrass plant.

Use of soil amendments may indirectly affect soil test results by altering the bulk density of the soil significantly from the assumed bulk density used by the soil testing laboratory for making calculations.

However, due to offsetting errors, lime and fertilizer recommendations using The Pennsylvania State University system would not be affected by differences in assumed versus actual soil weight.