Comparing Percentages of Green Mixtures

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Introduction

Soil mixtures for golf greens are a main discussion topic among golf course personnel. Even with current research on percentages of sand, soil, and organic matter to be incorporated into a given mixture, several discrepancies exist in expressing quantities of these three constituents.

The mechanical analyses of a soil to be used in a green mixture give quantities of sand, silt and clay expressed as percentages by weight. Yet quantities of this soil to be mixed with sand and organic matter are given in percentages by volume. Kunze (2) recognized this difference between weight and volume of a given quantity of soil and reported quantities of soil incorporated into one of several mixtures as 5 to 10% by volume or 2 to 4% by weight. This weight-volume ratio varies considerably with the density and the moisture content of the soil when it is measured. So, the two units of measurement must be correlated if both are to be used in calculating proper proportions to be mixed to produce a high quality putting green mixture.

Methods and Procedure

The experimental green at Kansas State University was constructed using ten different soil mixtures containing from 65 to 100% sand of two different grades, from 0 to 20 percent topsoil and from 0 to 15 percent peat moss, all based on volume.

A mechanical analysis by the Bouyoucos hydrometer method (1) on a random, composite sample from each of the soil mixtures, after one season of growth, compared relative quantities of sand, silt, and clay in each mixture with volume proportions of sand, soil, and peat originally used. These figures were compared with calculated percentages of sand, silt, and clay expected in control samples of each mixture based on an individual mechanical analysis of the topsoil and sand used in the mixtures.

The control samples were carefully measured and mixed in the laboratory using the same volume percentages

of sand, soil, and peat as were used in the experimental green. Bulk densities were determined for the two grades of sand and the topsoil in a loose condition similar to that of the sand and soil prior to mixing in the field. An exact duplication of the bulk density of the sand and soil used in the construction of the green was not possible, but a similar bulk density was established before laboratory measurements.

All sand and soil was then oven dried before measuring, and each volume proportion then was measured by weight on an oven-dry basis to insure the same volume measurements in each sample. The volume of peat moss used was measured by weight also, based on the bulk density of the peat in the bale. Half of the samples were mixed, including the peat moss. The other half were mixed omitting the peat moss, to determine the effects of this organic material on the results of the mechanical analysis of the mixtures. Bouyoucos (1) found very little effect from organic matter in the hydrometer method of mechanical analysis when the organic matter was not destroyed prior to the analysis.

Results and Discussion

The bulk densities determined for the two grades of sand, topsoil, and peat moss used in the laboratory samples were as follows: Blue mason sand, 1.74 g/cm^3, Kaw blow sand, 1.68 g/cm^3, topsoil, .86 g/cm^3, and peat moss, .15 g/cm^3.

The percentages by volume of sand, soil, and peat moss used in the construction of the green appear in Table I, along with the results of a mechanical analysis of a random composite sample of each of the mixtures.

The quantity of peat moss is not measured by the hydrometer method and, therefore, the weight of peat moss shown in the calculations is distributed among the fractions of sand, silt and clay. An examination of the data in Table II indicates a close relationship between the calculated and the actual percentage of sand, silt, and clay in the laboratory samples. The peat moss comprised .51 to 1.74 percent of the weight in the calculated percentages which the mechanical analysis results did not account for. This organic matter apparently is responsible for some of the variations in the quantities of soil particles. It can be seen from the table that the hydrometer method indicated, in most cases, more sand and less silt than was expected. The clay content was usually a little higher than expected.

In observing the soil columns during the mechanical analyses, the peat moss appeared to settle out with the sand or between the sand and silt layers, which could easily affect the amounts of these two constituents. The finer particles of organic matter, which remained in suspension longer, could have increased the clay content reading to a small degree.

In comparing field samples in Table I with the laboratory samples in Table II, one would conclude that more soil, or a volume of soil with a higher bulk density, was used in the construction of the green than was used in the control samples. This was possible because the stock pile of soil at the site of the green settled somewhat during the winter, increasing the bulk density, whereas, the soil measured in the laboratory was compacted less.

The volume-weight comparisons of the soil in the control mixtures (Table II) indicate a somewhat heavier soil than Kunze (2) used, 5 to 10 percent by volume or 2 to 4 percent by weight. In the 5 to 10 percent by volume of soil in the laboratory samples, the percent by weight was found to be 2.8 to 5.6 percent. Soil including large quantities of silt and sand would be expected to be denser than soils with smaller proportions of silt and sand.

Conclusions

These soil analyses were conducted in an attempt to determine the pro-

portions of sand, silt, and clay contained in a golf green mixture and to correlate these figures with current recommendations given in volume proportions.

The mechanical analysis data do not furnish an accurate indication of the exact volume proportions of the mixtures in the field. The data from samples composed of sand and soil with a known bulk density represent a correlation which is relatively close and indicate the possibility of using the Bouyoucos hydrometer method in estimating the proportions of sand, silt, and clay contained in golf green mixtures, provided analyses of the topsoil and sand included in the mixture are available.

References

(1) Bouyoucos, D. J. A recalibration of the hydrometer method for making mechanical analysis of soils. Agro. Jour. 1951, 43:434-438.

(2) Kunze, Raymond John. The effects of compaction of different golf green solid mixtures. USGA Journal and Turf Management, November 1957, 10 (6):24-27.

Table I. Soil mixtures used in the construction of the green.

	Composition of Mixtures			Results of Mechanical Analyses		
Kind of Sand Used	% Sand	% Soil	% Peat	% Sand	% Silt	% Clay
Kaw River Blow	65	20	15	85.1	9.9	4.9
Blue River Mason	65	20	15	84.6	10.5	5.1
Kaw River Blow	75	15	10	87.4	8.4	4.2
Blue River Mason	75	15	10	88.8	7.1	4.3
Kaw River Blow	85	10	5	92.3	4.2	3.5
Blue River Mason	85	10	5	92.2	4.7	3.2
Kaw River Blow	90	5	5	94.8	2.6	2.6
Blue River Mason	90	5	5	94.5	3.0	2.6
Kaw River Blow	100	—	—	98.4	.2	1.6
Blue River Mason	100	—	—	97.9	.6	1.6

The percentages of sand, silt and clay in the laboratory mixed control samples were calculated, based on content of the topsoil and other amendments added. Mechanical analyses of the topsoil used indicated 10% sand, 58% silt, and 24% clay. A small quantity of silt and clay contained in the 2 grades of sand influenced the calculations to a small degree. These calculations, along with actual quantities shown in the mechanical analysis, can be compared in Table II.

Table II. Calculated and actual percentages in control samples.

	Calculated Percentages				Results of Mechanical Analyses		
Mixture	Sand	Silt	Clay	Peat	%Sand	%Silt	%Clay
65KB	86.48	7.75	4.04	1.74	89.6	6.6	3.8
65BM	86.93	7.77	3.87	1.69	88.2	7.8	4.3
75KB	90.41	5.32	3.18	1.06	92.2	4.8	3.0
75BM	90.76	5.43	3.03	1.03	91.0	5.6	3.5
85KB	93.73	3.28	2.46	.55	95.6	1.8	2.6
85BM	94.05	3.44	2.33	.52	93.6	3.9	2.5
90KB	96.03	1.60	1.86	.53	97.0	1.0	2.0
90BM	96.12	1.83	1.85	.51	96.1	1.7	2.3
100KB	100	—	—	—	98.7	0.0	1.3
100BM	100	—	—	—	98.5	.3	1.2