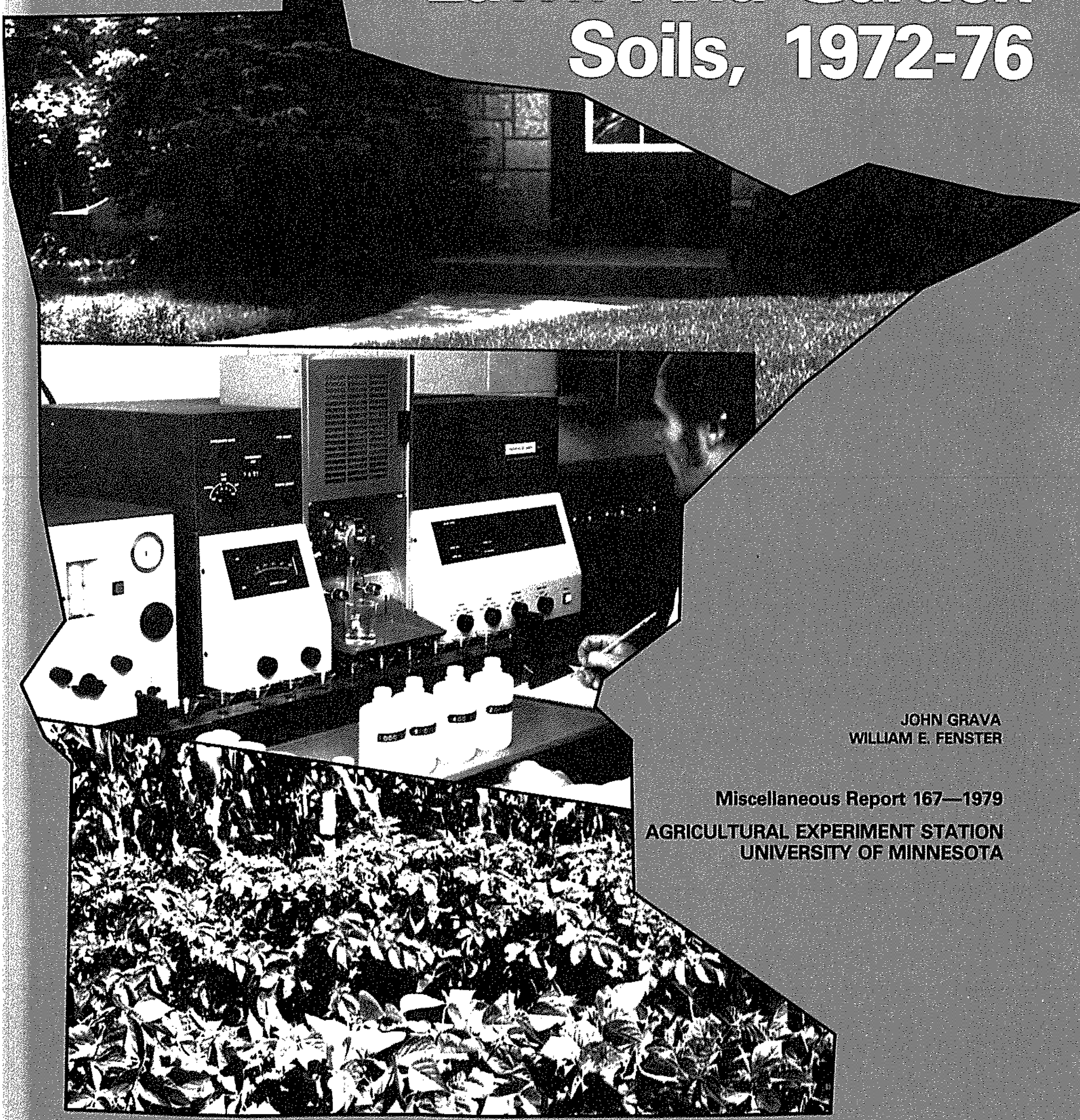
Fertility Levels Of Minnesota Lawn And Garden Soils, 1972-76



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Introduction

Chemical soil tests measure the relative nutrient status of the soil and assist in making recommendations for efficient and safe use of fertilizer and lime. Soil testing procedures have now progressed to the stage where the measurement of nutrient deficiencies as well as excesses is possible.

The University of Minnesota Soil Testing Laboratory has given assistance to homeowners and turf managers since its establishment in 1950. Lime and fertilizer recommendations were originally prepared by soil scientists at the laboratory, and then from 1955 to 1972, by county extension agents. A computerized recommendation program for garden and lawn samples was introduced in 1972. The computer program was designed to give recommendations, based on the individual customer's situation, faster and more efficiently than previously possible.

Soil test results have been summarized periodically since the establishment of the University of Minnesota Soil Testing Laboratory. The summaries published in 1964 reflected the native fertility of Minnesota soils (4). Occasionally, soil test results of samples received from Hennepin and Ramsey counties have been summarized to illustrate soil fertility problems encountered in the Twin City metropolitan area (Grava, J., 1958 and 1969, unpublished data). Soil test summaries are useful to the fertilizer and lime industries by pointing out areas of greatest need for their products. Extension personnel, teachers, and students find summary data helpful as teaching aids.

The data reported here summarize 19,224 test results for garden and lawn soil samples received between April 1, 1972, and December 31, 1976, by the University of Minnesota Soil Testing Laboratory. This report presents, in a general way, the fertility status of garden and lawn soils of Minnesota.

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An atomic absorption spectrophotometer set on emission mode is used to determine the potassium content in the soil extract. Soil tests measure the relative nutrient status and guide in the making of recommendations for efficient and safe use of fertilizer and lime.

Laboratory Procedures

The following is a brief description of analytical methods used by the University of Minnesota Soil Testing Laboratory (3).

Sample preparation. Samples are dried overnight in a metal cabinet equipped with a heating element and exhaust fan to remove moisture-laden air. The temperature in the cabinet is regulated so as not to exceed 37°C in order to approximate air-drying conditions.

Samples are crushed with a mechanical mortar and auger-grinder and passed through a 10-mesh sieve.

Soil pH and lime requirement. The pH is determined with a glass electrode pH meter on a 1:1, soil:water, suspension. Samples of mineral soils with pH values of less than 6.0 are saved for the lime requirement test.

Ten milliliters of SMP (Shoemaker, McLean, Pratt) buffer solution is added to the samples (5 grams of soil: 5 milliliters water). The buffer index of the suspension is determined with a pH meter, after the sample has been stirred intermittently for 20 minutes.

Extractable phosphorus. The soil phosphorus measured is that which is extracted by a solution consisting of 0.025 *N* HCl and 0.03 *N* NH_4F, commonly referred to as Bray-1 extractant. One gram of soil and 10 milliliters of extractant are shaken for 1 minute. The amount of phosphorus extracted is determined by measuring the intensity of the blue color developed in the extract when treated with ammonium molybdate-hydrochloric acid and amino-naphthol-sulfonic acid solutions. An absorption spectrophotometer is used to measure this color which is converted to pounds per acre of phosphorus (P) on the basis of 2 million pounds of a mineral soil in the surface 6 inches of an acre.

Exchangeable potassium. Potassium is extracted from the soil samples with 10 milliliters of normal neutral ammonium acetate mixed with 2 grams of soil. The amount of potassium removed by this reagent in 1 minute is designated as exchangeable potassium and is measured by passing the filtered extract through a flame emission spectrophotometer. Results are expressed as potassium (K) in pounds per acre.

Texture and organic matter. The relative amounts of sand, silt, and clay are estimated by the feel of the soil in a plastic condition. Clay loam, silty clay loam, and clay are termed *fine* textured soils. *Medium* textured soils include the loam, silt loam, and sandy loam. Loamy sand and sand are *coarse* textured soils. *Organic* soils include peat and muck.

Organic matter (O.M.) is estimated visually by comparing the color of a dry soil sample with a set of standard soils. The classifications used are: "low" for light-colored soils (O.M. less than 3.1 percent), "medium" for soils of intermediate color (O.M. approximately 3.1-4.5 percent), and "high" for dark-colored mineral soils (O.M. more than 4.5 percent). The "very high" category is used for peats and mucks.

Soluble salts. A saturation extract is prepared by adding a specific amount of demineralized water to the soil sample. After an equilibration time of 2 hours, about 5 milliliters of the saturation extract-filtrate are removed by suction and collected in a plastic tube. The electrical conductance is determined with a Solu Bridge and reported as millimhos per centimeter at 25°C.

Nitrogen in lawn and garden soils is usually not determined by a soil test because it is subject to considerable and rapid change. Soil analysis for nitrogen has little value for turf (2). Turfgrasses rapidly use up soluble nitrogen and very little nitrate is found under sod. Nitrogen recommendations for garden and turfgrasses are based on type of garden (vegetable or flower), management level, and species or variety requirements.

Source Of Data And Procedure

The University of Minnesota Soil Testing Laboratory employs a computer to integrate analytical results with data derived from research and information provided by the homeowner. The computer calculates and recommends fertilizer and lime for specific plants. Soil test results are placed on data processing punch cards and magnetic tape for summarization at the Computing Center, University of Minnesota, St. Paul Campus.[1]

Areas

The map (Figure 1) shows the location of six areas used in grouping summary data. Five counties (Anoka, Dakota, Hennepin, Ramsey, and Washington) of the Twin City metropolitan area were placed into Area 1. Fifty-eight percent of all samples included in the summary were received from this area. Carver and Scott counties sometimes are included in the Twin City

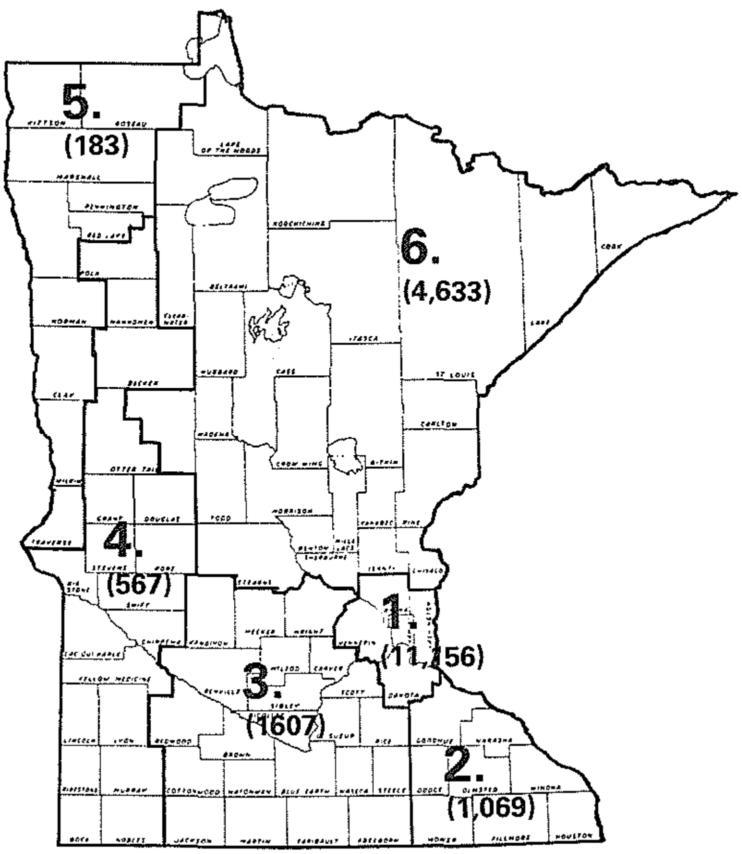
[1]The authors are grateful to David G. Schempp, Senior Analyst Programmer and the staff of the Computing Center, University of Minnesota, St. Paul campus, for their assistance in preparing the data for publication.

Fifty-four percent of the samples included in current summaries originated from home vegetable gardens. The summary data brings out the alkaline nature of many garden and lawn soils in Minnesota.

Table 1. Percent distribution of samples by category and area.

Category	Met.	SE	SC	WC and SW	NW	NE and NC	State
	Area						
	Percent of samples						
Vegetable garden	46	49	53	57	55	74	54
Flower garden	5	5	7	7	6	3	5
Home Lawn:							
(a) New seeding or sodding	5	4	5	3	1	4	5
(b) Established	31	21	18	14	8	8	23
Athletic fields, parks, institutional grounds	3	3	2	5	3	3	3
Golf courses	5	10	7	6	19	5	5
Miscellaneous	5	8	8	8	8	3	5

metropolitan area. Exclusion of these two counties, however, does not seriously affect the summary data because of the relatively low number of garden and lawn samples (Carver 186, Scott 146 samples). Remaining counties were grouped into Areas 2 to 6, approximately representing broad soil groups (1).



AREA 1. Twin City metropolitan
AREA 2. Southeast
AREA 3. South Central
AREA 4. West Central and Southwest
AREA 5. Northwest
AREA 6. Northeast and North Central

Figure 1. Breakdown of the state in six major areas. The total number of lawn and garden soil samples received from each area during 1972-76 is shown in parentheses ( ).

Soil Test Summary Data

This summary includes soil test results of 19,224 garden and lawn samples analyzed by the University of Minnesota Soil Testing Laboratory between April 1, 1972, and December 31, 1976. The summary data are presented in Tables 1 to 9.

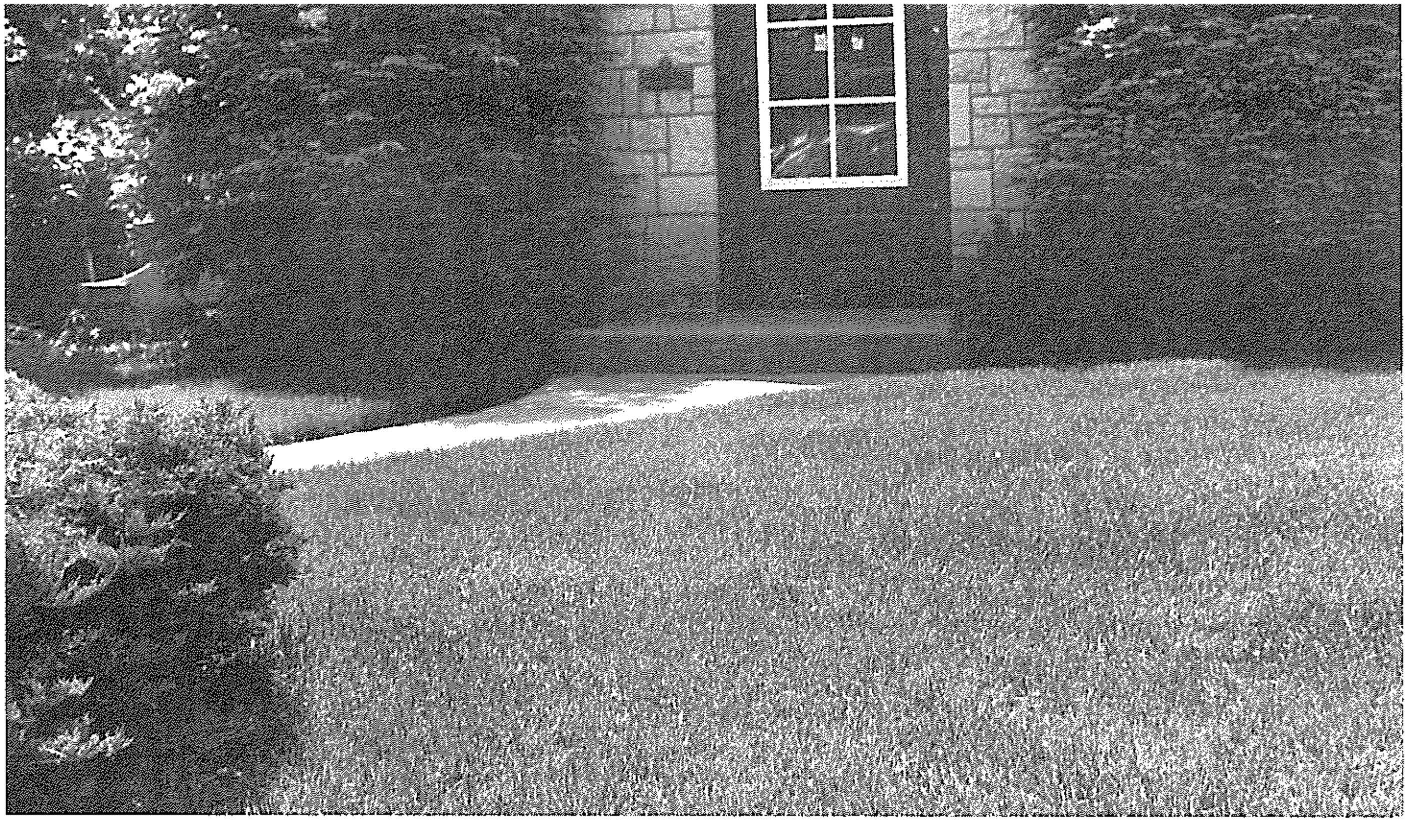
Category

Overall, samples from vegetable gardens comprise about 50 percent of the total number tested (Table 1). Homeowners of the Northeast and North Central area were particularly interested in the evaluation of their vegetable garden needs (three-fourths of their total samples fall into this category). For the state, nearly a third of soil samples were from home lawns. Lawn samples in the Twin City metropolitan area comprised as much as 36 percent of samples, while in Northwest, and Northeast and North Central areas, only about 10 percent of the samples originated from lawns. The great majority of recommendations were for established home lawns. Flower gardens, and the category consisting of athletic fields, parks and institutional grounds, each had 5 percent or less of the total number. Overall, only 5 percent of the total samples were collected from golf courses. The Southeast and Northwest areas, however, had 10 to 19 percent of the total samples in this category.

Grass Species And Varieties

Kentucky bluegrass was the predominant turfgrass species for which recommendations were made, comprising about 50 percent of the total (Table 2). Turf areas with elite cultivars, such as Merion Kentucky bluegrass, had 5 percent or less of the total. The relatively large percentage of samples with bentgrass, particularly in the Northwest area, presumably, were collected from golf courses.

Since very little nitrogen accumulates under sod and conventional analytical methods are unreliable, nitrogen recommendations for turfgrasses must be based on information provided by the customer. Such information includes: management level (watering intensity, removal of clippings), light



Attractive and durable lawns require careful management and a sufficient supply of plant nutrients. A relatively high phosphorus buildup in garden and lawn soils is indicated by soil test summaries.

intensity (species preferring sunny or shady areas), and variety. The approximate annual requirement for nitrogen varies from 3 or 4 pounds/1,000 square feet for common Kentucky bluegrass to 6 pounds for elite cultivars such as Merion (5). Low maintenance turf requires only 2 pounds of nitrogen/1,000 square feet.

Soil Texture And Organic Matter

The soil texture summary (Table 3) shows that the samples had predominantly medium texture. Included in this group are loam, silt loam, and sandy loam soils. The Northeast and North Central area had nearly 40 percent of coarse-textured soils

Table 2. Percent distribution of lawn samples by grass species and area.

	Area						
Grass species	Met.	SE	SC	WC and SW	NW	NE and NC	State
	Percent of samples						
Kentucky bluegrass	54	45	56	58	41	50	53
Merion Kentucky bluegrass	5	1	<1	<1	0	1	4
Bentgrass	9	24	16	22	43	25	13
Fescue	1	<1	1	1	0	2	1
Sunny area mixture	19	21	16	15	16	16	18
Shady area mixture	12	9	11	3	0	6	11

Table 3. Percent distribution of soil texture test results by area.

	Soil texture			
Area	Fine	Medium	Coarse	Organic
	Percent of samples			
Twin City metropolitan	1	76	21	2
Southeast	2	87	10	1
South Central	15	72	10	3
West Central and Southwest	17	68	14	1
Northwest	13	71	15	1
Northeast and North Central	1	57	38	4
State	3	71	23	3

Table 4. Percent distribution of organic matter test results by area.

	Soil organic matter			
Area	Low	Medium	High	Very High
	Percent of samples			
Twin City metropolitan	21	48	28	3
Southeast	30	47	22	1
South Central	11	39	47	3
West Central and Southwest	10	25	64	1
Northwest	8	26	65	1
Northeast and North Central	56	29	11	4
State	29	41	27	3

Table 5. Percent distribution of soil pH test results by area.

Area	Soil pH <6.0	6.0-6.4	6.5-6.9	7.0-7.4	>7.4
	Percent of samples				
Twin City metropolitan	10	14	22	31	23
Southeast	5	12	25	39	19
South Central	4	8	19	37	32
West Central and Southwest	3	7	13	34	43
Northwest	2	2	4	32	60
Northeast and North Central	29	24	21	17	9
State	13	16	21	29	21

(sand, loamy sand) while in the Southeast area, 87 percent of the samples were medium textured. Only 3 percent of the total samples were classed as organic soils.

Overall, 41 percent of the samples had medium organic matter content (Table 4). Fifty-six percent of the samples were classed about equally as low or high in organic matter.

Soil Reaction (pH)

Percent distribution of samples by soil pH and area is reported in Table 5. The sample distribution pattern for the whole state is reasonably close to that of the Twin City metropolitan area. It is important to note that only 13 percent of the soil samples submitted by customers for testing had a pH of less than 6.0. Generally, soils having a pH below 6.0 are considered as moderately to strongly acid and may require an application of liming materials. Only in the Northeast and North Central area acidity may be a problem in some soils as 29 percent of the samples had pH below 6.0.

The summary data actually brings out the alkaline nature of many lawn and garden soils in Minnesota. Twenty-one percent of the samples had a pH above 7.4. High soil pH may be related to the general alkalinity of the soils of an area or the use of topsoil having neutral or alkaline reaction. The high percentage of alkaline soil samples of the West Central and Southwest, and Northwest areas, reflect the well known native alkalinity of the soils (1, 4).

Relatively high pH in a lawn or garden soil also may result from either the addition of liming materials or irrigation with relatively hard water. It is estimated that in the Twin City metropolitan area, 1 inch of irrigation water may add calcium and magnesium bicarbonates equivalent to 0.5 to 1 pound of $CaCO_3$ per 1,000 square feet. It is assumed that irrigation with hard water has substantially contributed to the alkalinity of these soils. The summary is particularly significant in that it points out the generally high pH levels of lawn and garden soils (Table 9).

Overliming should be avoided. Availability of micronutrients, particularly iron and zinc, decreases when soil pH goes above 7, and deficiencies may occur. It is advisable for the homeowner who is anxious to lime the soil to do so only if a need is indicated by soil test.

Phosphorus

A relatively high phosphorus buildup in Minnesota garden and lawn soils is indicated by the summary data reported in Tables 6 and 9. Only 10 percent or less of the samples had extractable phosphorus readings of below 21, indicating medium or low availability. Nearly 50 to 60 percent of the samples had readings of more than 100 pounds per acre, considered to be a very high to excessive amount.

At least two factors seem to have contributed to such a high phosphorus buildup. First, phosphorus from topdress fertilizer applied to lawns remains in the top 3 inches of soil, which is the recommended sampling depth for turf. Secondly, for many years the needs of lawn and garden plants were met by homeowners by the use of commercial fertilizers such as 10-10-10 or 5-10-5, having N-P-K ratios of 1:1:1 or 1:2:1. Such fertilizers may be suitable for gardens or lawns at the time of establishment, but the requirements of grasses of established lawns are met better by fertilizers having N-P-K ratios of 5:1:2, 4:1:2 or 3:1:2 (2).

Phosphorus is an essential plant nutrient and must be present in adequate amounts. Its overuse must be avoided, however, because of concern for resource conservation, possible detrimental effects on environment, and cost of fertilizer. Current soil test recommendations, in cases of very high

Table 6. Percent distribution of extractable phosphorus test results by area.

Area	Extractable phosphorus, pounds/acre <21	21-50	51-100	>100
	Percent of samples			
Twin City metropolitan	5	16	31	48
Southeast	8	18	23	51
South Central	10	22	22	46
West Central and Southwest	10	16	20	54
Northwest	10	16	17	57
Northeast and North Central	8	14	20	58
State	7	16	27	50

phosphorus buildup, suggest the application of 0.5 pound of P_2O_5 per 1,000 square feet, or none at all. There is a need for a popularly available nitrogen-potassium fertilizer containing no phosphorus to meet the requirements of many lawns and gardens.

Potassium

The relative potassium availability is indicated in Tables 7 and 9. Roughly 50 percent of the soils, from the state as a whole, and the Metropolitan, Northeast and North Central, and Southeast areas, in particular, show low to medium test levels (K test readings of less than 200 pounds/acre). The summary data seem to reflect the native potassium availability of soils in an area. Generally, soils of these areas are not particularly well supplied with potassium (4). Soils of West Central and Southwest, Northwest, and South Central areas, generally considered to be relatively well supplied with potassium (4), showed only 18 to 26 percent of lawn and garden samples with exchangeable potassium levels of less than 200 pounds/acre. These same three areas also had the greatest proportion of samples with very high exchangeable potassium readings (more than 400 pounds/acre).

Table 7. Percent distribution of exchangeable potassium test results by area.

Area	Exchangeable potassium, pounds/acre			
	<200	201-300	301-400	>400
	.......Percent of samples.......			
Twin City metropolitan	47	25	13	15
Southeast	39	18	14	29
South Central	26	21	14	39
West Central and Southwest	18	14	13	55
Northwest	24	13	14	49
Northeast and North Central	48	19	13	20
State	44	22	13	21

Table 8. Percent distribution of soluble salt test results by area.

Area	Soluble salts, millimhos/centimeter			
	<2.0	2.0-4.0	4.1-8.0	>8.0
	.......Percent of samples.......			
Twin City metropolitan	95	3	1	1
Southeast	98	2	0	0
South Central	93	5	2	<1
West Central and Southwest	91	5	2	2
Northwest	96	0	0	4
Northeast and North Central	97	2	1	<1
State	95	3	1	1

Soluble Salts

The soluble salt test is used primarily to check for high amounts of salts in garden soils and possible salt damage to turfgrasses from salt used for deicing streets and sidewalks. Excess salt must be leached from the soil by intensive irrigation before the plants will grow normally.

Only 2 percent of the total 2,569 samples submitted for the soluble salt test showed levels of more than 4 millimhos/centimeter, which may have a detrimental effect on plant growth. The great majority of samples had readings of less than 2 millimhos/centimeter, indicating that the soils are "non-saline" and are not affected by salt problems. In some instances where salt damage is suspected, soils are tested too late since spring rains or irrigation may have changed the salt status before the test is made.

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Table 9. Percent distribution of pH, phosphorus and potassium soil test results by category in Twin City metropolitan area.

Category	Number of samples	Soil pH					Extractable phosphorus pounds/acre				Exchangeable potassium pounds/acre			
		<6.0	6.0-6.4	6.5-6.9	7.0-7.4	>7.4	<21	21-50	51-100	>100	<200	201-300	301-400	>400
	.......Percent of samples.......													
Garden (vegetable and flower)	5,727	9	13	21	33	24	5	11	24	60	43	22	14	21
Home lawns (new and established)	4,005	13	17	23	28	19	5	20	39	36	50	27	14	9
Golf courses	517	1	7	28	39	25	6	14	30	50	56	28	10	6
Athletic fields, parks, institutional grounds	357	4	7	20	34	35	12	30	42	16	53	27	11	9