ACCURACY OF HOME SOIL TEST KITS ON SOUTH DAKOTA SOILS

Rhoda Burrows
Dept. of Horticulture, Forestry, Landscape & Parks
South Dakota State University
Brookings, SD 57007

ABSTRACT

A variety of soil test kits are available for home use, but the accuracy of those "quick" tests has not been independently verified. We tested four kit types on five South Dakota garden and field soils, and compared the kit results to soil analyses by the South Dakota State University (SDSU) Soil Testing Laboratory. To emulate use of the kits by homeowners rather than trained scientists, Master Gardener and student volunteers were given the kits and soils and were instructed only to follow each kit's manual. In general, pH results were similar to SDSU soil test lab results, although one kit overestimated that of the lower pH soils by 1.0 to 2.0 units. The kits tended to underestimate nitrogen, phosphorus, and to a lesser extent, potassium levels. Each kit contained fertilizer recommendations based upon the test results and sometimes upon the crop grown, and kit recommendations were generally higher than SDSU recommendations. Fertilizer applications based on the kit results were mostly lower than those based solely on the crop grown without any consideration of soil test results. Thus, use of the kits by homeowners could result in decreased incidence of excessive fertilizer applications. Although the kits may be useful for home gardeners who wish to determine if their soils' N, P, and K levels are low or high, they should not be relied on for commercial production where soil nutrient levels should be more precisely managed.

Keywords

Soil tests, nutrient determination

INTRODUCTION

Home gardeners are strongly encouraged to have their soil tested to determine appropriate level of supplemental fertilization. In many cases, South Dakota soils already have an excess of potassium and phosphorous. If the homeowner has applied manure or other fertilizers in the recent past, even nitrogen may be adequate without further application. In the absence of a soil test, gardeners are often encouraged to apply an amount of fertilizer based on the total average consumption of the crop in question. Application of these materials when adequate or surplus levels are already present can lead to contaminated surface or groundwater, excess soil salts, and other problems.

A variety of soil fertility test kits are available for home use, offering convenience, nearly instant results, and reduced cost compared to testing by university or independent soil testing laboratories. However, the results of these "quick" tests are more qualitative (i.e., low to high) than quantitative, and their accuracy has not been independently verified. Our objective was to determine the usefulness of home soil test kits in determining garden soil pH, nitrogen, phosphorus and potassium content, and resulting fertilizer recommendation by testing a variety of South Dakota soils and comparing the results with that of the South Dakota State University Soil Test Laboratory.

METHODS

Soil Test Kits

- AccuGrow Soil Test Strips, Hach Company, P.O. Box 4659, Elkhart, IN 46514-0659 U.S.A.
- No-Wait Soil Test Kit, Farnam Companies Inc., P.O. Box 34820, Phoenix, AZ, 85067 U.S.A
- LaMotte Garden Soil Test Kit, LaMotte Company, PO Box 329, Chestertown, MD 21620 - USA
- Environmental Concepts Soil pH-N-P-K Test Kit, LusterLeaf Products, Ft. Lauderdale, FL USA

The soil tests of all kits are based on colorimetric methods, using either the color reaction of a soil:reagent solution or that of small strips dipped into the soil:reagent solution. Users then compare their results against a printed color chart to determine results. Kits differed in the amount of soil used for each test—as little as 1 mm^3 and up to approximately 10 mm^3. In all cases, the soil amount was determined by volume rather than weight, for the convenience of the user. Use of distilled water was strongly recommended.

Test Soils

1. Medium textured; home garden with 10 years of annual leaf compost additions, 7% organic matter
2. Medium textured; home garden with 15 years of chemical fertilization (no compost), 6.5% organic matter
3. Medium textured; Crop field with manure history, 5.5% organic matter
4. Coarse textured (very sandy) pasture soil, no fertilization, 0.6% organic matter
5. Medium textured; research farm (periodic cropping, some chemical fertilization), 3.5% organic matter

To emulate use of the kits by homeowners rather than trained scientists, Master Gardener and student volunteers were provided the kits, deionized water, and the test soils, with no instruction except to follow the directions provided by

each kit. Each soil *x* kit combination was tested by a minimum of four testers. The Environmental concepts kit was dropped from testing when the first three volunteers found the kit nearly impossible to use. A sample of each soil was also submitted to the South Dakota State University (SDSU) Soil Testing Laboratory for comparison. For comparison purposes, N, P, and K results were expressed on a relative scale of 0.5 to 5, with 0.5=very low and 5=very high. According to kit recommendations, "low" to "medium" levels (i.e., a score of 1 to 3) generated a recommendation for fertilizer addition according to the product literature. For each soil, analysis of variance was used to compare differences in test kit results for pH, N, P, and K.

RESULTS

In general, pH results of the test kits were similar to SDSU soil test lab results (Table 1). The exception was Accugrow, which tended to give higher pH values, especially in the lower pH sandy soil (Soil 4). No one test kit showed consistently greater or less variability for pH.

Variability of N,P, and K results within a given test kit was greatest for Soils 2 and 4 (Table 1). As with pH, no one test kit showed consistently greater or less variability for these three nutrients across soils (Table 1). The soils tested all had relatively high amounts of potassium, and potassium results were generally the least variable. However, variability did not always coincide with high or low values. For example, there was no variability within test kit results for Soil 5, but AccuGrow and LaMotte found high levels of nitrogen while No-Wait found low levels resulting in a fertilizer application recommendation.

Each kit contained fertilizer recommendations based upon the test results and sometimes upon the crop grown, and kit recommendations generally were higher than SDSU recommendations. NoWait underestimated nitrogen compared to the SDSU lab and other kits, resulting in recommendations for nitrogen fertilization (Table 2) for all five soils. Few differences between kits were noted for phosphorus values of the higher organic matter soils, but both NoWait and LaMotte resulted in phosphorous fertilizer recommendations beyond what was recommended by SDSU (Table 2). Accugrow results did not lead to recommendations of either phosphorous or potassium fertilization in any of the five soils, even in Soil 5, the only soil of the five for which the SDSU laboratory recommended supplemental phosphorous and potassium.

DISCUSSION

Our results indicate that home soil test kits are limited in precision, although they do reflect general trends of soil pH and nutrient levels. Our results are similar to results from somewhat more sophisticated colorimetric on-farm tests discussed by Allan and Killorn (1996) and Liebig et al (1996). Liebig et al. also found higher nitrate levels by the standard laboratory analysis compared to field tests, and attributed the difference to sample handling differences. However, all

Table 1. Mean soil pH and relative nutrient levels of soil test kit results: 0.5=Very Low, 1=Low, 2=Medium Low, 3= Medium, 4=High, 5=Very High

	pH	N	P	K
Soil 1				
No-Wait	7.5 (6)*	0.5 (0)*	3.6 (19)*	4.3 (12)*
AccuGrow	8.0 (0)	1.0 (0)	4.5 (0)	4.5 (0)
LaMotte	7.6 (6)	1.6 (68)	4.0 (0)	4.8 (11)
SDSU	7.8	3.0	5.0	5.0
Soil 2				
No-Wait	7.3 (6)	0.6 (35)	3.4 (14)	3.7 (14)
AccuGrow	7.7 (4)	1.4 (64)	3.5 (14)	3.3 (14)
LaMotte	7.7 (4)	2.0 (87)	4.0 (0)	4.0 (25)
SDSU	6.9	3.0	5.0	5.0
Soil 3				
No-Wait	7.0 (0)	1.4 (29)	3.9 (6)	3.2 (6)
AccuGrow	7.8 (6)	2.9 (24)	4.0 (0)	4.3 (11)
LaMotte	7.0 (6)	3.9 (6)	4.0 (0)	5.0 (0)
SDSU	6.9	4.0	5.0	5.0
Soil 4				
No-Wait	6.9 (3)	0.6 (37)	1.4 (69)	3.6 (15)
AccuGrow	7.5 (7)	1.7 (31)	3.3 (24)	3.3 (15)
LaMotte	5.9 (2)	0.5 (0)	2.0 (58)	4.6 (16)
SDSU	6.3	0.5	4.0	5.0
Soil 5				
No-Wait	7.5 (7)	1.0 (0)	1.0 (0)	3.9 (5)
AccuGrow	8.0 (0)	4.0 (0)	3.0 (0)	4.0 (0)
LaMotte	7.0 (1)	4.0 (0)	1.6 (56)	3.0 (54)
SDSU	7.5	5.0	3.5	3.5

Percent variability (coefficient of variation) within test kit and soil.

our subsamples were taken from the same air-dried and sieved soil samples, so the lower N determination by the "quick" colorimetric methods may indicate a need for recalibration of the "quick" test charts.

Variability in individual nutrient test results can be due to several factors. The soils themselves, even though well-mixed and drawn from the same bag, may not be completely uniform. Subsamples used for the test kits are small, from approximately 1- to 10 mm^3, depending on the kit, so it is quite possible the soil itself varied from sample to sample. Secondly, there may be differences in how

Table 2. Fertilizer recommendations based on test kit results (lb. actual element per 1000 ft.^{2}) by soil.

	N	P	K
Soil 1			
No-Wait	3-5	0-0.25	0
AccuGrow	1 trt*	0	0
LaMotte	4	3	1.5
SDSU	1	0	0
Soil 2			
No-Wait	1-5	0-.25	0-1
AccuGrow	1-2 trts*	0	0
LaMotte	2	3	3
SDSU	1.2	0	0
Soil 3			
No-Wait	3-5	0	0
AccuGrow	1 trt*	0	0
LaMotte	2	3	1.5
SDSU	0	0	0
Soil 4			
No-Wait	1-5	0.25-1	0-1
AccuGrow	1-2 trts*	0	0
LaMotte	5	5	2.5
SDSU	3	0	0
Soil 5			
No-Wait	1-3	0.25-.75	0-0.5
AccuGrow	0	0	0
LaMotte	2	5	3-5
SDSU	0	0-.85	1
Crop (no soil test):			
Vegetables	1-3	1-3	1-3

trt = "application per (fertilizer) package instructions"

various persons interpret the match between the color of the sample with reagent and the printed color swatches. Thirdly, there may be simple errors in measuring and/or timing mixing and settling of reagents, especially by lay people unused to laboratory procedures. Organic matter (OM) may affect the variability of nitrate availability in the soil over time, but did not appear to influence the variability

of the test kit results, as the low-OM soil (Soil 4) showed no less variability than those with relatively high OM (Soils 1 and 2).

Potassium within-kit results were generally the least variable, perhaps because the five soils tested all had medium-high to high amounts of potassium. However, comparison of P results within Table 1 reveal that similarly low or medium test values (eg., Soils 4 and 5) can be associated with high or low variability, even by the same test kit. Thus, the variability observed within any one test kit or nutrient had no apparent connection to the level of nutrient in any particular soil. This rules out the possibility of recommending one test kit over another for a given soil type (eg., high or low OM, medium or coarse texture, high or low nutrient-containing).

Fertilizer recommendations for any given soil can vary considerably, depending on not only crop, but also on expected growing conditions and target yield, as well as less tangible considerations. The LaMotte kit recommends at least minimal application of N, P, and K for every soil, regardless of soil test values, and its recommended P and K applications were always quite high. In most South Dakota soils, this addition would be unnecessary and, in cases where the soils have high salts, even detrimental.

CONCLUSIONS

Fertilizer applications based on the No-Wait and AccuGrow kit results are lower than recommendations based solely on the crop grown without consideration of soil test results (Table 2). Thus, even though these kits generally recommended higher application levels than indicated by the SDSU laboratory, use of these kits by homeowners would still result in decreased incidence of excessive fertilizer applications. However, although the kits may be useful for home gardeners who wish to determine if their soil's N, P, and K level is low or high, they should not be relied upon for commercial production where soil nutrient levels should be more precisely managed. The kits also lack the ability to determine soil texture, OM content, or soluble salt levels—all included in the standard SDSU "Garden Soil" analysis and useful in determining soil management by both homeowners and commercial growers.

ACKNOWLEDGEMENTS

Thanks to the many Master Gardener volunteers who donated their time to test soils with these kits, and to the South Dakota State University Soil Testing Laboratory for providing calibrated analysis of the soils.

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