

SOIL TESTING IN THE PADDOCK: AN EVALUATION OF A FIELD TEST KIT

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Summary. Soil testing is an essential component of sustainable production. However, sending samples to laboratories is costly and often long delays occur. The availability of accurate and simple test kits designed for use in the field, would be an advantage to growers and agronomists. This paper evaluates such a test kit produced by Palintest, for soil analysis in England. Six standard soils, used for quality assurance in laboratories throughout Australia were analysed for pH, conductivity, available P, K, Al and Mn and exchangeable K, Ca and Mg using this kit. The Palintest results were either not significantly different from, or high correlated to, the published results for all parameters tested, indicating the potential of this system for use in Australia.

INTRODUCTION

Soil testing has failed to gain wide acceptance in Australia, with only a small increase in sample numbers since 1989 (1). Reasons for the low utilisation of soil testing services include: farmers not having the time nor the expertise to collect soil samples; delays in receiving results from laboratories; lack of faith in results produced by laboratories linked to chemical companies; and cost of soil testing. The availability of simple, low cost field-based soil tests, could provide a solution to these problems.

Soil test kits for use in the field are available from Merck, Hach, ELE and Palintest. The Palintest test methods have been developed to correlate with standard methods used in soil laboratories in the United Kingdom and are used for the determination of pH, lime requirement, phosphate, potassium, nitrate, magnesium and calcium (V. Dart, pers. commun.). However, Palintest do not guarantee that acceptable results will be obtained for all soils.

The Palintest kit was evaluated in New Zealand in 1993 and was found suitable as a supplement to laboratory analysis or for field based testing (R. Dolby, pers. commun.). The system is used by consultants and agronomists in New Zealand to analyse soil samples and make "on the spot" fertiliser recommendations. Several soil test kits available in Australia were recently reviewed with variable results and the lack of calibration for Australian soils was identified as a potential limitation of tests developed overseas (2).

METHODS

The Palintest Soil Testing Kit: The kit is designed for use by people without access to normal laboratory facilities and uses reagents in tablet form. Soil samples are measured by volume using 2 ml or 10 ml scoops, avoiding the need to weigh samples or accurately dispense liquids.

The system utilises a simple transmittance photometer fitted with filters corresponding to predetermined wavelengths. pH and EC are measured using battery powered pH and EC meters following a 1:10 extraction in water.

Soil samples: Standard soil samples, available commercially from the State Chemistry Laboratory at Werribee, Victoria were used to evaluate the system.. These soils are used as quality assurance standards in laboratories in Australia and are supplied with mean and standard deviation values for a range of soil test parameters.

Parameters Analysed: Each soil sample was analysed for; pH in water and CaCl₂, EC, Olsen P, available K and Mn, and exchangeable K, Ca and Mg.

Extraction Procedures: Extraction procedures used were those recommended in the Palintest soil test book. A plastic extraction tube is filled to the 50 ml mark with distilled water, five extraction tablets added, the tube capped and shaken to dissolve the tablets. Different extraction tablets are available for each analysis to provide suitable extractants. One 2 ml or 10 ml scoop of soil is added to the tube and the mixture shaken for exactly 1 or 2 minutes, depending on the analysis.

Analysis: The extract is filtered and a suitable aliquot, (1.0 to 10.0 ml) is placed in a photometer tube. Reagent tablets added to the tube are crushed and dissolved. The tube is allowed to stand for a preset time (2 to 10 minutes) to allow the colour or precipitate to develop. The appropriate filter is selected and the photometer is set to 100% T using distilled water. The %T value of the sample is read from the meter and converted to concentration (mg/L) using the conversion tables supplied with the kit.

The analyses were carried out by first year degree students. Students were given four 3 hour training sessions to familiarise them with the methodology. Each soil was then analysed ten times for each test parameter and the mean and coefficient of variation (c.v. %) were calculated for each test and for each soil. Each set of 10 analyses was carried out over two days with a different student carrying out five analyses each day.

Statistical Analyses: All results were analysed statistically using CSS Statistica.

RESULTS AND DISCUSSION

The suitability of the Palintest system for in-field soil testing: The Palintest system contains tests for a wider range of tests than those discussed in this paper. Tests evaluated were selected to match the tests most often carried out in Australian laboratories with the proviso that adequate statistical data were provided for that parameter to allow reliable statistical analysis. The system is intended to provide quick, reliable results obtainable by users without formal chemistry training. The tablets are stable for long periods and the use of reagents in this form should minimise errors and reduce the need for highly trained technicians and complex laboratory equipment. While the Palintest Kit is not designed to replace laboratory analysis, the results discussed in this report indicate that it may provide a method that can rapidly determine soil parameters that influence farm management decisions or to check if specialist analysis is needed.

The test procedures used were straight forward, simple, rapid and did not require a laboratory or any additional equipment not included in the kit. The determination of pH, EC, Olsen P, available K, Ca and Mg could be completed in less than 30 minutes. The test instructions were well set out in the handbook and the chemistry of the extractions and colour development is clearly explained. No chemicals are used which are harmful to the operators or the environment.

Precision of the Palintest methods: The data in Table 1, shows the variability in the analytical results for 9 soil parameters. The c.v. (%) given for the Standard soils are the published values provided with the soils. All Palintest results gave cvs less than the published values. From a practical point of view, the variability of the Palintest results were within acceptable limits given the wide natural variability found in soils. The highest variability (c.v. 14%) was for Olsen P and this reflected the low Olsen P levels for the soils used. (The average was 9 mg/L).

Because the soil samples were prepared as AQA standards with strict sampling and preparation protocols used to minimise variability, the cv's shown above approximate the variability of the test method. In analysing normal field samples, greater variability could be expected because of the natural variability of soil nutrients.

Table 1. Comparison of average c.v. (%) for Palintest test results with published inter-laboratory values for 6 standard soil samples.

Average c.v. (%)

Parameter tested	Palintest Result	Published Value
pH (water)	1.6	2.0
pH (CaCl ₂)	1.5	1.7
EC (dS/m)	11.7	12.4
Olsen P	14.2	33.7
Avail K	5.5	16.8
Ex K	8.1	15.9
Ex Ca	7.9	8.9
Ex Mg	4.4	8.6
Ex Mn	6.0	13.7
Average	6.9	16.1

Accuracy of Palintest Results: The results for the ten replicate Palintest determinations carried out on the six standard soils are given in Table 2. For all parameters, except the exchangeable bases, the Palintest results are similar to the published mean values for the soils. Correlations between Palintest and standard soil methods for pH in water and calcium chloride, EC and Olsen P were linear with R^2 values and slopes close to unity. This indicates that the results are not statistically different to those from standard laboratory procedures for these parameters.

Table 2. Comparison of Palintest results (PT) and published results (AQA) for nine soil tests parameters on six standard soils.

Test	Soil	1	Soil	2	Soil	3	Soil	4	Soil	5	Soil	6
	PT	AQA	PT	AQA	PT	AQA	PT	AQA	PT	AQA	PT	AQA
pH (water)	6.1	6.2	6.62	6.65	6.58	6.63	7.05	7.14	5.35	5.38	7.61	7.63
pH (CaCl ₂)	5.1	5.1	6.42	6.47	5.54	5.59	6.19	6.25	4.74	4.79	6.59	6.66
EC (dS/m)	0.15	0.17	12.8	13.2	0.1	0.1	0.18	0.16	0.23	0.21	0.48	0.50
Olsen P	9.5	8.1	7	6.5	11	8	6	8	17	15	4.1	4.5
Avail K	414	404	350	329	365	353	630	695	230	195	500	520
Ex K	1	1	0.9	0.8	0.93	0.77	1.61	1.9	0.59	0.43	1.28	1.30
Ex Ca	2.8	3.1	5	8	3.2	4.4	7.2	10.7	2.8	3.6	4.5	6.8
Ex Mg	10	5	38	22	2.0	1.7	25.6	14.9	1.6	1.2	17.6	9.7
Av. Mn	70	55	60	41	49	45	68	68	40	33	33	33.6

Palintest results for exchangeable Ca, K and Mg were significantly different to the given values for the soils. However, the Palintest results were strongly correlated with the standard values for the 6 soils, indicating that Palintest results could be used to calculate the values for the exchangeable bases. Correlation coefficients and the regression equations are given in Table 3. Regression equations are also shown for available K and Mn.

Table 3. Regression equations and % R^2 values for correlations between Palintest results and published results for selected analyses on the 6 standard soils.

Test Parameter	Correlation Equation	% R ² Value
Exchangeable Ca	Ca = -0.022 + 0.008 * PT Ca	98
Exchangeable Mg	Mg = 0.13 + 0.005 * PT Mg	99
Exchangeable K	K = -0.16 + 0.003 * PT K	98
Available K]	K = 3 + 0.965 * PT K	99
Available Mn	Mn = -.02 + 0.932 * PT Mn	93

Potential limitations of the system: The apparent simplicity and ease of use of the test kit is the greatest potential source of error through operator complacency. As with any chemical analysis, operator training is essential and care needs to be exercised at all times if reliable results are to be obtained. Test procedures must be followed exactly. In particular, timing must be accurate and a high standard of hygiene is required at all times.

In the initial two training sessions students frequently obtained c.v. (%) greater than 100 % between duplicates done at different times. Causes for this included; failing to filter samples correctly, contamination between tests, incorrect extraction or colour development times, incorrect reagent tablets used and incorrect filters selected. However, once familiar with the Palintest approach the c.v. (%)’s rapidly fell to acceptable levels (Table 1).

One potential problem with the Palintest system that was not addressed in this study is that the methods recommend that fresh soil (i.e. moist soil that has been sieved) be used for all analyses. All data presented in this report were obtained on oven dried ground soil samples, prepared to minimise variation. Consequently the report looks at the test method’s accuracy and precision, not sampling error. It is the author’s opinion that many clay or clay loam soils would prove difficult to sieve and thus it would be very difficult to obtain representative 2 ml samples from a soil sample that was not dried and ground to pass through a 2 to 3 mesh prior to analysis, particularly when wet or dry. This could be a major limitation to field testing on many soil types and needs to be investigated before the Palintest system is used to analyse fresh soil samples.

CONCLUSIONS

The results of this study indicate that the Palintest system provides simple and rapid field-based soil testing, that should be suitable for most soil types likely to be encountered in agricultural and horticultural areas in Australia. This finding is consistent with those from New Zealand and England. The results obtained for the parameters tested were highly correlated to the standard values for the soils tested and it is likely that some of the Palintest methods not evaluated could also provide useful results. The two main potential problems appear to be, the need for care in the analyses and concerns about using fresh soil samples due to the difficulty of obtaining a representative sample for the analysis.

REFERENCES

1. Peverill, K.I. 1993 Aust. J Exp. Agric. 33 (8), 963-971
2. Rayment, G.E. 1993 Aust. J Exp. Agric. 33 (8), 1015-1028