

Palintest®

Complete Soil Management Kit

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To ensure maximum accuracy, this kit should only be used in conjunction with Palintest products.

All Palintest instruments and reagents are manufactured in, and distributed from the UK.

PALINTEST SOIL TEST SYSTEM

Soil testing plays a vital role in modern agricultural and horticultural management. Regular assessment of major nutrient levels in the soil is essential to make fertiliser recommendations and to ensure optimum growing conditions.

The Palintest system of soil testing is unique. Simple to use test equipment, and reagents in stable tablet form, mean that reliable results can be obtained by all users - with or without formal training in soil analysis.

This is why the Palintest system is used by farmers, growers and specialists throughout the world - you can rely on years of Palintest experience for your soil testing needs.

The Palintest Photometer system offers a precise modern means of soil analysis. The system features the Soil Test 10 - an advanced solid-state digital-readout colorimeter instrument.

The Palintest Soil Test 10 is integrated with the Palintest range of soil extraction and reagent tablets. It therefore offers an instrumental method of analysis for an extensive range of soil tests.

The tests are carried out by first extracting the nutrients or trace elements from the soil, and then testing the extracts by simple colorimetric test procedures. The Soil Test 10 accurately assesses the colour formed in the test sample and displays the reading as a digital readout, and in this way gives an accurate measure of the soil parameter under test

The tests for soil pH and lime requirement are carried out without the need for separate extraction. Certain tests, for example, those for calcium and chloride, do not use the photometer. These tests are carried out on the appropriate soil extract using the Palintest tablet count method.

SOIL ANALYSIS APPLICATIONS

Soil analysis is a complex subject. The wide variation in soil types and crops under cultivation has promoted many different methods of soil analysis. Often the results obtained must be related to the method of analysis used.

Whilst precise laboratory analysis undoubtedly has a vital role, simple methods of field testing can be immensely useful in soil management. In particular results can be obtained quickly and economically. Field tests can be conducted in order to make fertiliser recommendations, to check if further tests are needed or to determine if samples should be collected for specialist analysis.

Palintest soil tests are equally suited for use in the field and in the laboratory. Palintest soil test kits are an important part of any agricultural or horticultural management programme.

CORRELATION OF RESULTS

Chemical elements are often strongly bonded or complexed within the soil structure. Soil analysis measures the nutrients or trace elements which are 'exchangeable' or 'extractable' under the conditions of the test. The amounts will depend on the nature of the extraction method and the time of contact. Thus whilst a general relationship exists between different methods of soil analysis, precise correlation can sometimes be difficult.

In developing Palintest methods regard has been paid to standard laboratory methods of soil testing (Ref - 1, 2). Correlations have been established for the pH, Lime Requirement, Nitrate (N), Phosphate (P), Potassium (K) and Magnesium (Mg) methods (Ref - 3). These tests should give similar results to United Kingdom ADAS methods for normal agricultural soils. However, in view of the wide variation in soil types it is not possible to guarantee that precisely similar results will be obtained in all cases.

Test results should always be considered in relation to the fertiliser programme applied and the conditions of cultivation. In the event of unexpected test results being obtained, such as very high or very low values, then it is recommended that samples are submitted for laboratory analysis. A guide level for each nutrient is provided on page 37.

FERTILISER RECOMMENDATIONS

Fertiliser recommendations are outside the scope of these soil test instructions. It is suggested that users refer to standard fertiliser recommendations such as those published by ADAS (Ref - 4) in the United Kingdom and by government agencies in other countries.

REFERENCES

- 1 The Analysis of Agricultural Materials; Agricultural Development and Advisory Service; Ministry of Agriculture, Fisheries and Food; Reference Book RB 427.
- 2 Methods of Soil Analysis; American Society of Agronomy, 1965, 5th printing 1979.
- 3 Comparison of Palintest Soil Test Methods with Standard Laboratory Procedures, Colin Marks and Valerie Argent, Palintest Ltd.
- 4 Fertiliser Recommendations; Agricultural Development and Advisory Service; Ministry of Agriculture, Fisheries and Food; Reference Book 209.

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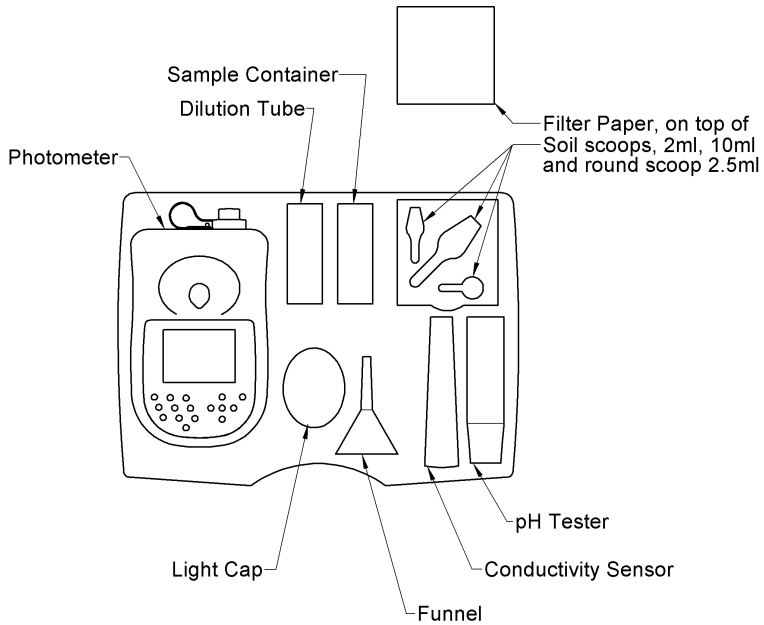
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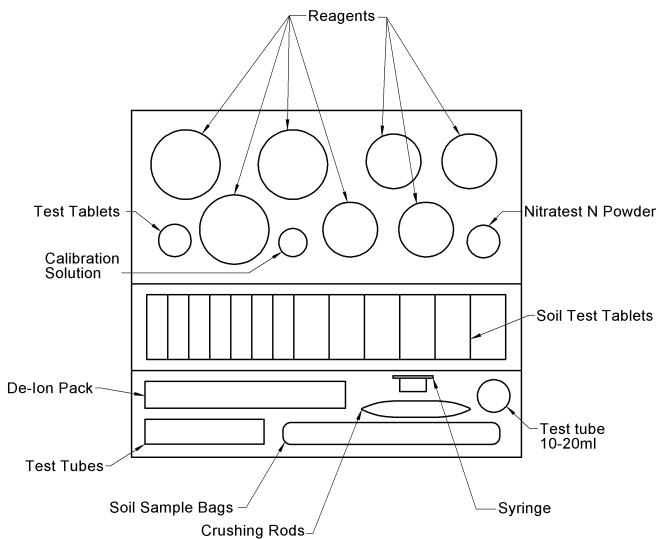
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Schematic Diagram of the Kit

Case :-



Reagent Bag :-



BASIC PRINCIPLES OF THE SOIL TEST 10 PHOTOMETER

Tests are carried out on the extract by adding the appropriate reagent tablet or tablets to a test tube containing the sample. A distinctive test colour is formed and this is indicative of the concentration of the parameter being tested.

The Soil Test 10 is used to measure the colour formed in the test.

Light is passed through the sample, then through an optical filter onto a photodetector.

When a measurement is being carried out, a 'BLANK' tube is first inserted into the photometer. It is important to understand the meaning of the term 'BLANK' tube. The 'BLANK' tube is a test tube containing the extracted sample only. This tube is used to compensate for any inherent colour in the sample and automatically sets the instrument for each test. **This 'BLANK' may not necessarily be a transparent solution.**

Once the photometer has been set, the 'SAMPLE' tube is then inserted into the instrument. The 'SAMPLE' tube is the test tube containing the coloured test solution prepared by adding the reagent tablets to the sample in accordance with the test instructions. After the sample tube has been inserted, the photometer will display the test result in the form of a digital readout.

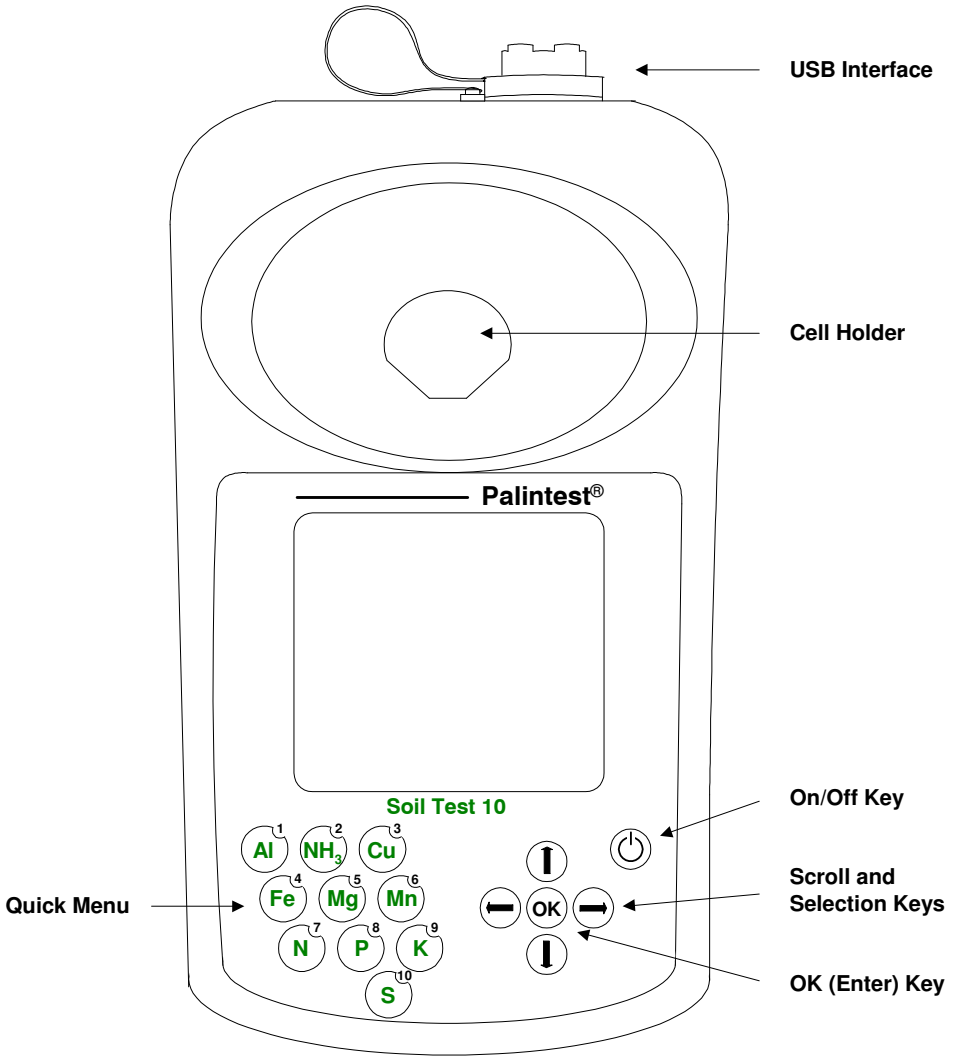
Different tests are carried out on the Soil Test 10 by selecting the appropriate program. The test instructions describe precisely how each of the tests should be carried out.

Some of the instructions will indicate that the sample should be prepared in a certain way, or that the tablets should be added in a certain manner. It is important to observe these instructions in order to obtain accurate results.

Note that certain of the tests are based on turbidity methods. In these tests the photometer is used to measure the degree of cloudiness which forms in the test solution.

For further instructions on using your Soil Test 10 photometer, please see Page 33.

The Soil Test 10



SOIL SAMPLING

A soil sample should be collected from each plot or area to be examined. Separate samples should be collected from each area, which differs in soil type, previous cropping history or type of soil management.

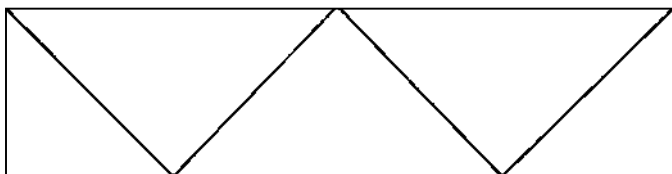
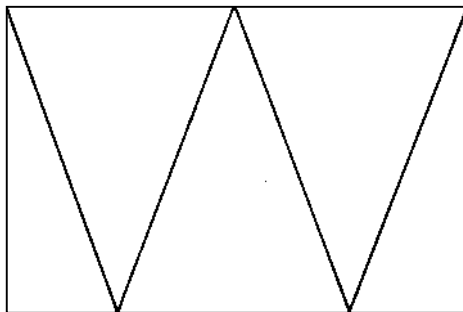
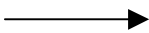
Preferably, samples of soil should be taken using a soil sampling auger which enables 'cores' of soil to be taken from below the surface. Alternatively, a piece of narrow rigid tubing may be used. Between 10 and 25 individual cores should be taken from each area to make up the soil sample for analysis. It is customary when sampling large areas of agricultural land to take cores along the shape of an imaginary W covering the area being sampled. Cores should not be taken close to hedgerows, under trees or adjacent to buildings.

To provide the sample for analysis, the individual cores should be be thoroughly mixed in a bucket. Stones and foreign materials should be removed by hand. The soil can be passed through a 2 mm sieve or similar if this is available. The sample can then be transferred to a polythene sample bag (PT 301).

For field analysis, the tests may be conducted directly on the moist sample. Where analysis is to be carried out at a later time, it is preferable to dry the sample by spreading it out on a tray or plastic sheet and allowing it to stand in air.

Sampling Patterns

Direction of Furrow



SOIL EXTRACTION

Soil extraction is the first stage in soil testing. The soil is shaken with an extracting solution in order to extract the nutrient or trace element from the soil.

Certain groups of tests use the same extraction procedure. It is only necessary to prepare a single extract for each group of tests.

NOTE THAT THE EXTRACTION PROCEDURES USE TWO DIFFERENT SIZES OF SOIL SAMPLE SCOOP - 2 ml AND 10 ml.

An outline of the extraction scheme used for the various tests is shown in the following table :-

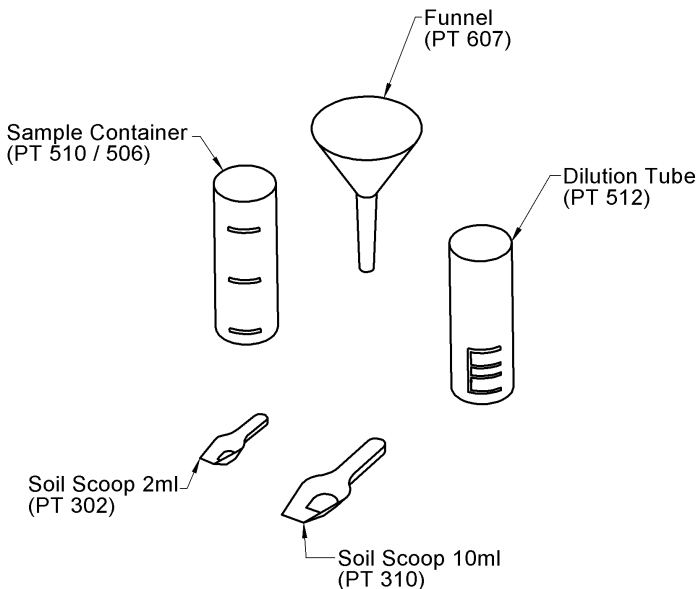
Test	Extract	Extract Chemical	Extraction Tablets	Water	Soil
Soil pH Lime Requirement	N/A		No extraction required. Tests are carried out directly on the soil sample.		
Nitrate (N) Manganese	Extract N	1M Ammonium Chloride	One x level blue extraction scoop Extraction N Powder plus universal spoonful of Nitratetest N Powder	50 ml	2 ml
Phosphate (P)	Extract P	0.5M Sodium Bicarbonate	5 x Extraction P tablets	50 ml	2 ml
Potassium (K)	Extract K	0.1M Magnesium Acetate	One x level blue extraction scoop Extraction K Powder	50 ml	2 ml
Calcium (Ca) Magnesium (Mg) Aluminium (Al) Ammonia (N)	Extract A	1M Potassium Chloride	5 x Extraction A tablets	50 ml	10 ml
Copper (Cu) Iron (Fe)	Extract C	0.05M disodium EDTA	5 x Extraction C tablets	50 ml	10 ml
Chloride (Cl) Sulphate (S)	Extract W	Aqueous	Deionised Water Only	50 ml	10 ml

Equipment

The equipment required to prepare the soil extracts, and included in Palintest soil test kits, is listed below :-

Palintest Sample Containers, 100/50 ml, plastic	PT 510/PT 506
Soil Scoop, 2 ml	PT 302
Soil Scoop, 10 ml	PT 310
Blue Extraction Scoop	ZP0432
Universal Spoon	ZP0465
Filter Funnel, 7 cm, plastic	PT 607
Filter Papers, 11 cm diameter	PT 618

It is important to ensure that the sample containers and filter funnel are clean before the start of each extraction. It is particularly important to wash out all traces of the previous extracting solution as these can seriously contaminate subsequent tests. The sample containers and filter funnel must be thoroughly washed out and then rinsed with deionised water between each extraction. Syringes used to measure extract solutions must be thoroughly cleaned between each test.



Filtering and Extract

After the soil has been shaken with the extracting solution for the prescribed period, it must be filtered through filter paper to produce an extract. The filtration is carried out in the following manner.

Take a filter paper circle, fold in half and then fold again into a quarter. Insert a finger between the folds and form the paper into the shape of a cone. Insert the filter paper cone into the filter funnel then place the funnel on the top of a clean sample container.



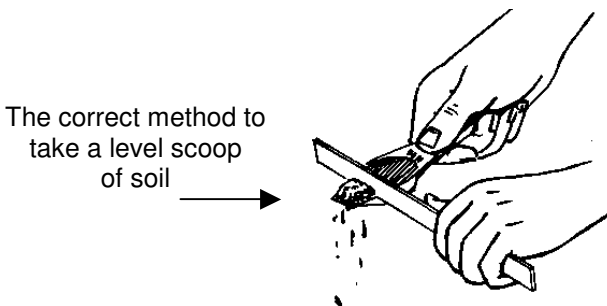
It is not necessary to collect all of the extract solution. Most of the Palintest procedures have been based on a 10 ml sample of extract so as to minimise the filtration time. Just collect sufficient extract for the tests to be carried out then discard the rest of the soil slurry.

Temperature

Temperature affects the rate of soil extraction and the rate of chemical reactions. Palintest soil tests have been calibrated at a temperature of 20°C. Palintest soil extraction procedures and chemical tests should be carried out with the solution as close to 20°C as possible for optimum results.

Important

The success of the soil tests will depend on following the test instructions carefully and on maintaining clean working conditions throughout the test procedures. Always wash and rinse equipment thoroughly before and after use.



Test Instructions

Soil pH

Soil pH is a measure of the hydrogen ion activity and is important in determining the availability of plant nutrients. Agricultural soils generally lie within the pH range of 4 - 8.

Neutral soils have a pH value close to 7.0. Soils are considered alkaline if the pH is above 7, and acidic if the pH is below 7. Soils below pH 5 are strongly acidic and will only support acid loving plants.

Lime Requirement

The 'Lime Requirement' of a soil is a measure of the quantity of liming material required to raise the pH of the soil to a specified value. The specified pH value is 6.5 for mineral soil, 6.2 for organic soil and 5.8 for peaty soil. It is not necessary to test soils where the existing pH is higher than these values since in such cases the lime requirement will be zero.

In the Palintest Lime Requirement test, the soil is shaken with a pH buffer and the extent to which the soil modifies the buffer pH is used to determine the lime requirement. The test is carried out as an extension of the Soil pH test. The value given is the amount of calcium carbonate required to raise a 20 cm depth of soil to the pH value specified for the particular soil type.

Soil pH and Lime Requirement can be determined using a Palintest pH Sensor. Use of the sensor offers a rapid and convenient method of measuring these parameters. Operating instructions for Palintest pH sensors are given in pocket tester instructions (page 50).

Reagents and Equipment

Palintest pH Sensor	PT 151
Palintest Lime Buffer Tablets	ST-2210
Soil Scoop, 2 ml	PT 302
Sample Container	PT 506/PT 510

Test Procedure

Soil pH

- 1 Take two level 2 ml scoops of soil and place in the sample container. Add deionised water up to the 10 ml mark.
- 2 Cap container and shake gently for one minute.
- 3 Insert the pH electrode into the container and take the soil pH reading.

Lime Requirement

- 1 Take one level 2 ml scoop of soil and place in the sample container. Add deionised water up to the 10 ml mark.
- 2 Add one Lime Buffer tablet, cap container and shake gently for two minutes.
- 3 Insert the pH electrode into the container and take the modified pH reading of the buffer.
- 4 Refer to the Lime Requirement table appropriate to the type of soil under test. The tables show the Lime Requirement expressed in terms of Calcium Carbonate (CaCO_3). Quantities are given in various units commonly used in agriculture.

Mineral Soils

Mineral soils contain less than 10% organic material :-

Soiltester Reading (Modified pH)	Lime Requirement (CaCO_3)			
	tonne/ha	gram/m ²	cwt/acre	oz/sq yard
4.0	30	3000	240	90
4.5	25	2500	200	75
5.0	20	2000	160	60
5.5	15	1500	120	45
6.0	10	1000	80	30
6.5	4	400	30	12
7.0	0	0	0	0
7.5	0	0	0	0
8.0	0	0	0	0

Organic Soils

Organic soils contain 10 - 25% organic material :-

Soiltester Reading (Modified pH)	Lime Requirement (CaCO ₃)			
	tonne/ha	gram/m ²	cwt/acre	oz/sq yard
4.0	32	3200	225	95
4.5	26	2600	210	78
5.0	21	2100	165	61
5.5	15	1500	120	45
6.0	10	1000	75	28
6.5	4	400	30	12
7.0	0	0	0	0
7.5	0	0	0	0
8.0	0	0	0	0

Peaty Soils

Peaty Soils contain greater than 25% organic material :-

Soiltester Reading (Modified pH)	Lime Requirement (CaCO ₃)			
	tonne/ha	gram/m ²	cwt/acre	oz/sq yard
4.0	34	3400	270	100
4.5	28	2800	225	85
5.0	22	2200	180	65
5.5	17	1700	135	50
6.0	11	1100	85	32
6.5	5	500	40	15
7.0	0	0	0	0
7.5	0	0	0	0
8.0	0	0	0	0

The lime requirement values given in the foregoing tables should be regarded as maximum values. Over-liming should be avoided as this may give rise to trace element deficiencies.

Liming Materials

The results of the Palintest Lime Requirement test are given in terms of calcium carbonate (ground limestone or chalk). In practice a variety of liming materials are used and regard must be paid to the neutralising value of these materials in order to determine the amounts required from the results given as calcium carbonate.

CONDUCTIVITY

Electrical conductivity provides a means of assessing the level of soluble salts in soil. The test is particularly useful for saline soils, or for glasshouse or other soils which have been subject to prolonged irrigation.

There are various different techniques for measuring soil conductivity. In the method given below the soil is extracted with water at a soil: water ratio of 1:5, and the filtered extract is tested using a Palintest Conductivity Meter. This method provides a quick and simple means of comparing the conductivity or soluble salt content of different soil samples.

Equipment

Palintest Conductivity Meter	PT 159
Sample Container	PT 506/PT 510

Operating instructions for the conductivity meter are given in the pocket tester instructions.

Conductivity Procedure

- 1 Fill the sample container to the 50 ml mark with deionised water.
- 2 Add one 10 ml scoop of soil, cap tube and shake for two minutes.
- 3 Allow the soil to settle before taking a reading

Conductivity Measurement Test Procedure

- 1 Take the sample container containing the extract and dip in the Conductivity Meter Probe.
- 2 Take the conductivity reading on the meter. The result is displayed in either μS (microsiemens) or mS (millisiemens).

NITRATE (0 – 25 mg/l N)

Nitrate nitrogen (N) is an important plant nutrient which promotes foliar growth and increased yield.

In the Palintest Nitrate test the soil is extracted using 1M ammonium chloride at a soil:water ratio of 1:25. The extracted nitrate is reduced to nitrite during the extraction stage and then reacted to form a red azo-dye. The intensity of the red colour produced is proportional to the nitrate level in the soil sample and is determined by using a Palintest Soil Test 10.

Reagents and Equipment

Palintest Nitricol N Tablets	ST-2240
Nitratetest N Powder	ST-2237
Extraction N Powder	ST-2106
Palintest Photometer	PT 751 SOIL
Soil Scoop, 2 ml	PT 302
Blue Extraction Scoop	ZP0432
Universal Spoon	ZP0465
Sample Container	PT 506/PT 510
Palintest Test Tubes, 10 ml	PT 595/5
Filter Funnel	PT 607
Filter Paper	PT 618

Extract N Procedure

A blue extraction scoop is included in the kit for this procedure, however, it is important that this scoop should NOT be used for measuring soil.

- 1 Fill the sample container to the 50 ml mark with deionised water.
- 2 Add one level blue extraction scoop of Extraction N powder, cap tube and shake to disperse.
- 3 Add one level 2 ml scoop of soil, cap tube and shake for one minute.
- 4 Add one level universal spoonful of Nitratetest N Powder, cap tube and shake for one minute.

Filter and collect Extract N in a clean sample container. For optimum results carry out the test as soon as sufficient extract has been collected.

Test Procedure

- 1 Fill a round glass test tube to the 10 ml mark with Extract N.
- 2 Add one Nitricol N tablet, crush and mix to dissolve.
- 3 Stand for 10 minutes to allow full colour development.
- 4 Select Test N and take photometer reading in usual manner.
- 5 The soil Nitrate result is displayed as mg/l N.

PHOSPHATE (0 – 150 mg/l P)

Phosphate (P) is a major plant nutrient. It is particularly beneficial in stimulating root growth.

In the Palintest Phosphate test the soil is extracted using 0.5M sodium bicarbonate at a soil:water ratio of 1:25. The extracted phosphate is then reacted with ammonium molybdate under reducing conditions in acidic solution to form a blue coloured complex. The intensity of the blue coloration is proportional to the phosphate level in the soil sample and is determined by using a Palintest Soil Test 10.

Reagents and Equipment

Palintest Acidifying S Tablets	ST-2275
Palintest Phosphate P Tablets	ST-2260
Palintest Extraction P Tablets	ST-2116
Palintest Photometer	PT 751SOIL
Soil Scoop, 2 ml	PT 302
Palintest Test Tubes, 10 ml	PT 595/5
Sample Container	PT 506/PT 510
2 ml Syringe	PT 362
Filter Funnel	PT 607
Filter Paper	PT 618

Extract P Procedure

- 1 Fill the sample container to the 50 ml mark with deionised water.
- 2 Add five Extraction P tablets, cap tube and shake to disintegrate.
- 3 Add one level 2 ml scoop of soil. Cap tube and shake for one minute. With acid soils some effervescence may be produced - release tube cap periodically to allow any pressure build-up to escape.
- 4 Filter and collect Extract P in a clean sample container.

Test Procedure

- 1 Using the plastic syringe take exactly 2 ml Extract P. Discharge the syringe into a round test tube, then fill tube to the 10 ml mark with deionised water.
- 2 Add one Acidifying S tablet, crush and mix to dissolve.
- 3 Add one Phosphate P tablet, crush and mix to dissolve.
- 4 Stand for 10 minutes to allow full colour development.
- 5 Select Test P and take photometer reading in usual manner.
- 6 The soil Phosphate result is displayed as mg/l P.

POTASSIUM (0 - 450 mg/l K)

Potassium, the third of the major nutrients, increases resistance to disease and hardens plant tissue.

In the Palintest Potassium (K) test the soil is extracted using 0.1M magnesium acetate at a soil:water ratio 1:25. The extracted potassium is reacted with sodium tetraphenylboron to form an insoluble white complex which produces a turbidity in the test sample. The degree of turbidity is proportional to the potassium level in the soil and is measured by using a Palintest Soil Test 10.

Reagents and Equipment

Palintest Potassium K Tablets	ST-2280
Palintest Extraction K Powder	ST-2127
Palintest Photometer	PT 751SOIL
Palintest Test Tubes, 10 ml	PT 595/5
Soil Scoop, 2 ml	PT 302
Blue Extraction Scoop	ZP0432
Sample Container	PT 506/PT 510
Filter Funnel	PT 607
Filter Paper	PT 618

Extract K Procedure

A blue extraction scoop is included in the kit for this procedure, however, it is important that this scoop should NOT be used for measuring soil.

- 1 Fill the sample container to the 50 ml mark with deionised water.
- 2 Add one level blue extraction scoop of Extraction K powder, cap tube and shake to disperse.
- 3 Add one level 2 ml scoop of soil, cap tube and shake for one minute.
- 4 Filter and collect Extract K in a clean sample container.

Test Procedure

- 1 Fill a round glass test tube to the 10 ml mark with Extract K.
- 2 Add one Potassium K tablet, crush and mix to dissolve.
- 3 Stand for two minutes, a cloudy solution indicates the presence of potassium.
- 4 Select Test K and take photometer reading in usual manner.
- 5 The soil potassium result is displayed as mg/l K.

Notes

- 1 Photometer readings on turbidity-based tests should be carried out under shaded conditions to prevent light being reflected into the instrument. Always use the light cap in brightly lit environments.
- 2 High levels of ammonia nitrogen may interfere with the potassium test. The test should not be carried out within two weeks following the application of farmyard manure or slurry.

MAGNESIUM (0 – 500 mg/l Mg)

Magnesium is an essential element for the growth of green plants. The ratio of calcium to magnesium is also an important factor in determining the availability of nutrients. If there is an excess of magnesium over the amount of calcium in the soil, plant growth can be seriously affected.

In the Palintest Magnesium test, the soil is extracted using 1M potassium chloride at a soil:water ratio of 1:5. The extracted and exchanged magnesium is then reacted to form an orange complex. The reagent produces a yellow colour in the absence of magnesium. The intensity of the orange colour produced is proportional to the magnesium level in the soil sample and is determined by using a Palintest Soil Test 10.

Reagents and Equipment

Palintest Magnecol S Tablets	ST-2440
Palintest Extraction A Tablets	ST-2136
Palintest Photometer	PT 751SOIL
Palintest Test Tubes, 10 ml	PT 595/5
Soil Scoop, 10 ml	PT 310
Syringe, 1 ml plastic	PT 361
Sample Container	PT 506/PT 510
Filter Funnel	PT 607
Filter Paper	PT 618

Extract A Procedure

- 1 Fill the sample container to the 50 ml mark with deionised water.
- 2 Add five Extraction A tablets, cap tube and shake to disintegrate.
- 3 Add one level 10 ml scoop of soil, cap tube and shake for two minutes.
- 4 Filter and collect Extract A in a clean sample container.

Test Procedure

- 1 Using the plastic syringe take exactly 1 ml Extract A. Discharge the syringe into a round test tube, then fill the tube to the 10 ml mark with deionised water.
- 2 Add one Magnecol S tablet, crush and mix to dissolve.
- 3 Stand for five minutes to allow full colour development.
- 4 Select Test Mg and take photometer reading in usual manner.
- 5 The soil Magnesium result is displayed as mg/l Mg.

CALCIUM (0 – 2500 mg/l Ca)

The amount of exchangeable calcium is an important factor in classifying soil and in making fertilizer recommendations. Calcium stimulates root development and influences the uptake of other nutrients. The ratio of calcium to magnesium is particularly important in determining nutrient availability.

In the Palintest Calcium test the soil is extracted using 1M potassium chloride at a soil:water ratio of 1:5. The exchanged and extracted calcium is then determined by the Palintest tablet count method. Tablets are added to a sample of the extract one at a time until the colour changes from pink to violet. The result of the test is calculated from the number of tablets added to the extract sample.

Reagents and Equipment

Palintest Calcium S Tablets	ST-2297
Palintest Extraction A Tablets	ST-2136
Sample Container	PT 510/PT 506
Soil Scoop, 10 ml	PT 310
Filter Funnel	PT 607
Filter Paper	PT 618

Extract A Procedure

- 1 Fill the sample container to the 50 ml mark with deionised water.
- 2 Add five Extraction A tablets, cap tube and shake to disintegrate.
- 3 Add one level 10 ml scoop of soil, cap tube and shake for two minutes.
- 4 Filter and collect Extract A in a clean sample container.

Test Procedure

- 1 Take 10 ml Extract A in the sample container. Add deionised water to make up to approximately the 50 ml mark. (The amount of deionised water added is not critical - this is merely to increase the working volume of the solution to aid dissolving the tablets and observation of the colour change).
- 2 Add one Calcium S tablet and shake the container until the tablet disintegrates.
- 3 Continue adding tablets one at a time in this manner until the colour of the solution changes from pink to violet.

- Note the number of Calcium S tablets used. Calculate the result of the test using the formula given below. This gives the calcium level in the soil expressed as mg/l Ca :-

$$\text{Calcium (mg/l)} = \text{Number of Tablets} \times 250$$

Low Calcium Soils

For soils with an expected low calcium content, it is preferable to carry out this test on 50 ml of Extract A, made up to approximately 100 ml with deionised water. The result should then be calculated as follows :-

$$\text{Calcium (mg/l)} = \text{Number of Tablets} \times 50$$

ALUMINIUM (0 – 50 mg/l Al)

Aluminium is a commonly occurring element found in the majority of inorganic soils. Soluble aluminium can be toxic to many plants. Solubility is promoted by acid conditions and liming is often used to prevent the take-up of aluminium.

In the Palintest Aluminium test the soil is extracted using 1M potassium chloride at a soil:water ratio of 1:5. The extracted and exchanged aluminium is reacted with eriochrome cyanine under acid conditions to produce a red coloured complex. In the absence of aluminium, the reagent gives a yellow coloration. The intensity of the red colour produced is proportional to the aluminium level in the soil and is determined by using a Palintest Soil Test 10.

Reagents and Equipment

Palintest Aluminium No 1S/ No 2S Tablets	ST-2345
Palintest Extraction A Tablets	ST-2136
Palintest Photometer	PT 751SOIL
Palintest Test Tubes, 10 ml	PT 595/5
Syringe, 1 ml plastic	PT 361
Sample Container	PT 510/PT 506
Soil Scoop, 10 ml	PT 310
Filter Funnel	PT 607
Filter Paper	PT 618

Extract A Procedure

- 1 Fill the sample container to the 50 ml mark with deionised water.
- 2 Add five Extraction A tablets, cap tube and shake to disintegrate.
- 3 Add one level 10 ml scoop of soil, cap tube and shake for two minutes.
- 4 Filter and collect Extract A in a clean sample container.

Test Procedure

- 1 Using the plastic syringe take exactly 1 ml Extract A. Discharge the syringe into a round test tube, then fill the tube to the 10 ml mark with deionised water.
- 2 Add one Aluminium No 1S tablet, crush and mix to dissolve.
- 3 Add one Aluminium No 2S tablet, crush and mix to dissolve. Avoid vigorous agitation.
- 4 Stand for five minutes to allow full colour development.
- 5 Select Test Al and take Photometer reading in usual manner.
- 6 The soil Aluminium result is displayed as mg/l Al.

AMMONIA (0 – 75 mg/l N)

Ammonia nitrogen is a rapidly available form of nitrogen and encourages green plant growth. Ammonia nitrogen forms the basis of some nitrogen fertilizers which are mainly used on horticultural soils and composts.

In the Palintest Ammonia Nitrogen test the soil is extracted using 1M potassium chloride at a soil:water ratio of 1:5. The extracted ammonia is then reacted to form a green indophenol complex. The reagents produce a yellow colour in the absence of ammonia. The intensity of the green colour produced is proportional to the ammonia nitrogen content of the soil sample and is determined by using a Palintest Soil Test 10.

Reagents and Equipment

Palintest Ammonia No 1S/No 2S Tablets	ST-2320
Palintest Extraction A Tablets	ST-2136
Palintest Photometer	PT 751SOIL
Palintest Test Tubes, 10 ml	PT 595/5
Syringe, 1 ml plastic	PT 361
Sample Container	PT 510/PT 506
Soil Scoop, 10 ml	PT 310
Filter Funnel	PT 607
Filter Paper	PT 618

Extract A Procedure

- 1 Fill the sample container to the 50 ml mark with deionised water.
- 2 Add five Extraction A tablets, cap tube and shake to disintegrate.
- 3 Add one level 10 ml scoop of soil, cap tube and shake for two minutes.
- 4 Filter and collect Extract A in a clean sample container.

Test Procedure

- 1 Using the plastic syringe take exactly 1 ml Extract A. Discharge the syringe into a round test tube, then fill the tube to the 10 ml mark with deionised water.
- 2 Add one Ammonia No 1S tablet and one Ammonia No 2S tablet. Crush and mix to dissolve both tablets.
- 3 Stand for 15 minutes to allow full colour development.
- 4 Select Test NH₃ and take photometer reading in usual manner.
- 5 The soil Ammonia result is displayed as mg/l N.

CHLORIDE (0 – 1000 mg/l Cl)

Chlorides are the major components of soil salinity in most soils. Chloride levels are particularly high in coastal regions, or in areas which have been flooded with sea water. Soils with a chloride level above 1000 mg/l would be regarded as saline and sensitive crops would suffer. At increasingly high levels only salt tolerant crops can be grown.

In the Palintest Chloride test the soil is extracted with water at a soil:water ratio of 1:5. The extracted chloride is tested by the Palintest tablet count method. Tablets are added to a sample of the extract one at a time until the colour changes from yellow to brown. The result of the test is calculated from the number of tablets added to the extract sample.

Reagents and Equipment

Palintest Chloride S Tablets	ST-2367
Sample Container	PT 510/PT 506
Soil Scoop, 10 ml	PT 310
Filter Funnel	PT 607
Filter Paper	PT 618

Extract W Procedure

- 1 Fill the sample container to the 50 ml mark with deionised water.
- 2 Add one 10 ml scoop of soil, cap tube and shake for two minutes.
- 3 Filter and collect Extract W in a clean sample container.

Test Procedure

- 1 Take 10 ml Extract W in the sample container. Add deionised water to make up to approximately the 50 ml mark. (The amount of deionised water added is not critical - this is merely to increase the working volume of the solution to aid dissolving the tablets and observation of the colour change).
- 2 Add one Chloride S tablet and shake the container until the tablet disintegrates.
- 3 Continue adding tablets one at a time in this manner until the colour of the solution changes from yellow to brown.
- 4 Note the number of Chloride S tablets used. Calculate the result of the test using the formula given below. This gives the chloride level in the soil expressed as mg/l Cl :-

$$\text{Chloride (mg/l)} = (\text{Number of Tablets} - 1) \times 125$$

Saline Soils

When testing known or suspected saline soils, Extract W should be diluted x2 or x4. Conduct the test on this diluted sample then multiply the result by the appropriate factor.

Low Chloride Soils

For soils with an expected low chloride content, it is preferable to carry out this test on 50 ml of Extract W, made up to approximately 100 ml with deionised water. The result should then be calculated as follows :-

$$\text{Chloride (mg/l)} = (\text{Number of Tablets} - 1) \times 25$$

COPPER (0 – 25 mg/l Cu)

Copper is an important trace element. Copper deficiency can cause stunting of growth and reduction in crop yield.

In the Palintest Copper test the soil is extracted using 0.05M disodium EDTA at a soil:water ratio of 1:5. The extracted copper is reacted with a specific copper reagent to produce a purple coloration. The intensity of the purple colouration is proportional to the copper level in the soil sample and is determined by using a Palintest Soil Test 10.

Reagents and Equipment

Palintest Coppercol No 1S/No 2S Tablets	ST-2455
Palintest Extraction C Tablets	ST-2146
Palintest Photometer	PT 751SOIL
Palintest Test Tubes, 10 ml	PT 595/5
Sample Container	PT 510/PT 506
Soil Scoop, 10 ml	PT 310
Filter Funnel	PT 607
Filter Paper	PT 618

Extract C Procedure

- 1 Fill the sample container to the 50 ml mark with deionised water.
- 2 Add five Extraction C tablets, cap tube and shake to disintegrate.
- 3 Add one level 10 ml scoop of soil, cap tube and shake for two minutes.
- 4 Filter and collect Extract C in a clean sample container.

Test Procedure

- 1 Fill a round glass test tube to the 10 ml mark with Extract C.
- 2 Add one Coppercol No 1S tablet, crush and mix to dissolve.
- 3 Add one Coppercol No 2S tablet, crush and mix to dissolve.
- 4 Select Test Cu and take photometer reading in usual manner.
- 5 The soil Copper result is displayed as mg/l Cu.

IRON (0 – 25 mg/l Fe)

Iron is an important trace element and is essential to plant growth. Iron is thought to act as a catalyst to photosynthesis.

In the Palintest Iron test the soil is extracted using 0.05M disodium EDTA at a soil:water ratio of 1:5. The extracted and exchanged iron is then reacted with a specific iron reagent 1,10-phenanthroline to form an orange coloured complex. The intensity of the orange coloration produced is proportional to the iron level in the soil sample and is determined by using a Palintest Soil Test 10.

Reagents and Equipment

Palintest Iron MR No 1S/No.2S Tablets	ST-2370
Palintest Extraction C Tablets	ST-2146
Palintest Photometer	PT 751SOIL
Palintest 10 ml Test Tubes	PT 595/5
Sample Container	PT 506/PT 510
Soil Scoop, 10 ml	PT 310
Filter Funnel	PT 607
Filter Paper	PT 618

Extract C Procedure

- 1 Fill the sample container to the 50 ml mark with deionised water.
- 2 Add five Extraction C tablets, cap tube and shake to disintegrate.
- 3 Add one level 10 ml scoop of soil, cap tube and shake for two minutes.
- 4 Filter and collect Extract C in a clean sample container.

Test Procedure

- 1 Fill a round glass test tube to the 10 ml mark with Extract C.
- 2 Add one Iron MR No 1S tablet, crush and mix to dissolve.
- 3 Add one Iron MR No 2S tablet, crush and mix to dissolve.
- 4 Stand for 10 minutes to allow full colour development.
- 5 Select Test Fe and take photometer reading in usual manner.
- 6 The soil Iron result is displayed as mg/l Fe.

MANGANESE (0 – 25 mg/l Mn)

Manganese is an important trace element which promotes germination and functions in the metabolism of plant growth.

In the Palintest Manganese test the soil is extracted using 1M ammonium chloride under reducing conditions at a soil:water ratio of 1:25. The extracted and exchanged manganese is then oxidised to permanganate, and reacted with leuco-malachite green indicator to form a blue-green complex. The intensity of the blue-green colour produced is proportional to the manganese level in the soil sample and is determined by using a Palintest Soil Test 10.

Reagents and Equipment

Palintest Manganese No 1S Tablets	ST-2390
Palintest Manganese No 2S Tablets	ST-2400
Extraction N Powder	ST-2106
Nitratest N Powder	ST-2237
Palintest Photometer	PT 751SOIL
Palintest Test Tubes, 10 ml	PT 595/5
Syringe, 1 ml plastic	PT 361
Sample Container	PT 506/PT 510
Soil Scoop, 2 ml	PT 302
Blue Extraction Scoop	ZP0432
Universal Spoon	ZP0465
Filter Funnel	PT 607
Filter Paper	PT 618

Extract N Procedure

A blue extraction scoop is included in the kit for this procedure, however, it is important that this scoop should NOT be used for measuring soil.

- 1 Fill the sample container to the 50 ml mark with deionised water.
- 2 Add one level blue extraction scoop of Extraction N powder, cap tube and shake to disperse.
- 3 Add one level 2 ml scoop of soil, cap tube and shake for one minute.
- 4 Add one level universal spoonful of Nitratest N Powder, cap tube and shake for one minute.

Filter and collect Extract N in a clean sample container. For optimum results carry out the test as soon as sufficient extract has been collected.

Test Procedure

- 1 Using the plastic syringe take exactly 1 ml Extract N. Discharge syringe into a round test tube, then fill the tube to 10 ml mark with deionised water.
- 2 Add two Manganese No 1S tablets, crush and mix to dissolve.
- 3 Add two Manganese No 2S tablets, crush and mix to dissolve. Cap tube immediately.
- 4 Stand for 20 minutes to allow full colour development.
- 5 Select Test Mn and take photometer reading in usual manner.
- 6 The soil Manganese result is displayed as mg/l Mn.

SULPHATE (0 – 300 mg/l S)

Sulphate sulphur is essential for normal plant growth. Crops grown in soils with very low sulphur content can exhibit sulphur deficiency.

In the Palintest Sulphate test, the soil is extracted with water at a soil:water ratio of 1:5. The extracted sulphate is then reacted with barium chloride to form an insoluble barium salt which produces turbidity in the test sample. The degree of turbidity is proportional to the sulphate level in the soil sample and is determined by using a Palintest Soil Test 10.

Reagents and Equipment

Palintest Sulphate S Tablets	ST-2410
Palintest Photometer	PT 751SOIL
Palintest Test Tubes, 10 ml	PT 595/5
Sample Container	PT 506/PT 510
Soil Scoop, 10 ml	PT 310
Filter Funnel	PT 607
Filter Paper	PT 618

Extract W Procedure

- 1 Fill the sample container to the 50 ml mark with deionised water.
- 2 Add one 10 ml scoop of soil, cap tube and shake for two minutes.
- 3 Filter and collect Extract W in a clean sample container.

Test Procedure

- 1 Fill a round glass test tube to the 10 ml mark with Extract W.
- 2 Add one Sulphate S tablet, crush and mix to dissolve. A cloudy solution indicates the presence of sulphate.
- 3 Select Test S and take photometer reading in usual manner.
- 4 The soil Sulphate result is displayed as mg/l S.

SOIL TEST 10 PHOTOMETER INSTRUCTIONS

Your Palintest Soil Test 10 photometer is designed to give long and trouble-free operation. To ensure you get the best out of this photometer, please read these instructions carefully and follow the procedures recommended.

The photometer is suitable for use in both the laboratory, or in the field. It is sturdy and robust but should always be regarded as a scientific instrument. Treat it in the same way that you would a watch or a camera. It is designed to resist moisture and spills but careless use will almost certainly result in damage or reduce the life of the instrument.

Getting the Best Results

To get the best results follow these simple guidelines :-

- 1 Read the test instructions carefully and carry out the tests precisely as instructed. Become familiar with the instructions for each test.
- 2 Add the tablets to the sample in the manner described in the instructions. Crush or allow to disintegrate as indicated. Use a separate crushing rod for each tube. Do not shake the test tubes in order to dissolve the tablets.
- 3 Place cap on the test tube when the tablets have dissolved. For most tests it does not matter if a few small undissolved particles remain, provided these have settled to the bottom of the tube.
- 4 Before taking Soil Test 10 readings ensure that the outside of the tube is clean and dry. Use a tissue to wipe off any water drips or condensation.
- 5 Wash test tubes, caps and crushing rods thoroughly under a running tap after use. Brush off any stains or deposits. Dry on a clean cloth or rinse with deionised water before re-use.
- 6 Replace any test tubes which become scratched or permanently stained.

Use the light cap when working in strong, direct sunlight.

Carrying Out the Tests Rapidly

The following hints should help in developing a technique for carrying out the tests rapidly. Once you are familiar with the individual test procedures it should be possible to carry out a series of tests at the same time. The following procedure should be adopted :-

- 1 Note the tests which are required to be carried out.
- 2 Prepare a sample tube for each of the tests according to the test instructions.
- 3 Add test tablets to each tube in the manner described. Crush or allow to disintegrate as instructed. Cap the tubes.
- 4 Ensure that the tablets have properly dissolved then take the photometer reading on each tube in turn

Diluting the Sample

When the test result is outside the concentration range of the test, the Soil Test 10 will display the '>>' symbol. In such cases it is necessary to dilute the sample and repeat the test. If the result is close to the top of the scale and a more accurate result is required, a dilution may be used to increase the sensitivity of the test :-

- 1 Take a Dilution Tube (PT 512) and fill to the x2 mark with the extract. Make up to the 'Deionised Water' mark with deionised water. Replace the tube cap and mix.
- 2 Carry out the test on the diluted sample in a 10 ml test tube as per the normal test instructions.
- 3 Switch the photometer into SYSTEM mode, then select Dilution Factor 'On'. Press [OK] key to switch back into PHOTOMETER mode.
- 4 Take the photometer reading in the normal manner. Photometer display sequence will ask for entry of dilution factor. Key in the factor '2'.
- 5 The test result displayed will represent the concentration in the original water sample.

Samples may be diluted to a greater extent if necessary. Enter the dilution factor appropriate to the dilution used. Note that it is not possible to dilute samples in the pH test.

Care and Maintenance

Palintest kits are designed to give long service and require very little maintenance. The main requirement is to keep the components in a clean condition. Spillages of test solutions should be wiped up immediately with a damp cloth. In addition to routine cleaning, the test tubes and sample containers should be washed periodically in warm soapy water.

Deionised Water

Deionised water is required for sample dilution and for the general rinsing of test tubes, etc. The Palintest De-Ion Pack has been specially developed to provide deionised water for use with test kits both in the field and in the laboratory.

The Palintest De-Ion Pack produces approximately five litres of deionised water in 2 - 5 minutes from mains water or from clean natural water sources. Instructions for using the De-Ion Pack are given on the product label and carton.

Power Supply

The photometer is designed to be powered either from alkaline batteries or via the USB socket. To use mains power, the instrument is connected using the USB Connection Cable (PT 746) plugged to the Mains Adapter (PT 745). Alternatively, if the USB connection cable is plugged to a computer, power will be drawn from the computer.

The photometer features a battery indicator – see ‘System Mode’ functions. A minimum voltage of 3.0V is needed to operate the photometer.

In addition to the above feature, a battery-warning message will appear automatically on the display when the battery voltage becomes low. The batteries should be replaced as soon as possible after the warning message appears. Stored data in the instrument memory will not be lost during battery replacement.

Replacing the Batteries

The battery compartment in the base of the instrument is secured by four screws. To replace the batteries, remove the cover and install the batteries, observing the correct polarity as indicated. Use 3 x 1.5V 'AA' alkaline batteries or equivalent.

To avoid corrosion damage through leakage, remove batteries from the instrument if it is to be stored or left unused for a long period of time.

Cleaning the Optics

Any build-up of dirt or deposits may interrupt light transmission and affect readings.

To clean the optics, undo the two screws to remove the optics base plate. Gently clean the internal surfaces of the optics with a soft, non-abrasive cloth. Deposits may be removed with a slightly dampened cotton bud. Replace the optics base plate and re-fasten the screws.

The photometer is fitted with long-life light sources and contains no user-serviceable components. If the instrument requires servicing or repair, this can be arranged through our Technical Services Department.

Nutrient Level Guide

Parameter	Expression of Results	Maximum Recommended Concentration/Value*
Soil pH	-	7.5
Nitrogen	mg/l	20
Phosphate	mg/l	40
Potassium	mg/l	250
Calcium	mg/l	2000
Magnesium	mg/l	180
Conductivity	$\mu\text{S/cm}$	2000

* = the maximum limits of each macronutrient will depend upon both the type of crop that is being cultivated and upon the local environmental conditions. Consult www.palintest.com for further details.

The five main elements absorbed from the soil by plants are nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg). They are all classified as macronutrients due to plants adsorbing them on a relatively large scale. Nitrogen, phosphate and potassium are the three that are commonly in sufficiently short supply in soil to inhibit high crop yields.

Nitrogen (adsorbed as ammonium or nitrate ions) is essential for all plant growth as it is a major component of amino acids, the building blocks of proteins. Nitrogen levels need to be sufficiently high as to support plant growth and photosynthesis, whilst excessive levels of nitrogen in the soil may lead to increasing plant vulnerability from insect and fungal organisms.

Plants adsorb phosphorus, as orthophosphate from the soil. Phosphorus plays a fundamental role in the very large number of enzymic reactions within the cells of the plant. Phosphorus deficiency results in the starvation of the plant and can occur with few warning signs in plant condition.

Potassium is the third essential nutrient a plant requires and is used primarily in the synthesis of amino acids. It is also thought to be important the photosynthesis process within plant cells.

Calcium deficiency seems to affect the proper growth of the root tips. It usually occurs in acidic soils and has a detrimental effect on plants by allowing other substances to accumulate in the plant. Excessively high calcium content in the soil can suppress the uptake of magnesium and potassium by the plant roots.

Magnesium is an important constituent of chlorophyll in plants and therefore deficiency (as with calcium, generally occurring in acidic soils) reduces crop yields. Magnesium is also thought to be important in the transport of phosphate throughout the plant.

FEATURES AND TECHNICAL SPECIFICATION

Application	For the use of analysing soil samples using Palintest tablet reagent systems.
Instrument Type	Single-beam colorimeter with built-in colour filters and pre-programmed test calibrations.
Peak Wavelengths	445 ± 5nm, 495 ± 5nm, 555 ± 5nm, 570 ± 5nm, 605 ± 5nm and 655 ± 5nm
Range	1 - 100%T
Accuracy	± 1%T
Display	Large graphic display with option of backlight.
Language	Test identification and prompts in English, French, German, Spanish and Italian.
Timer	Clock and timer feature to log test results and audible alarm for timing test procedure.
Units	Direct-reading of test results in mg/l or ppm.
User Selectable Options	10 digit sample number entry, dilution factor, time/ date, date format, system lock and rounding of results.
Date Format	Date format selectable as day/month/year or month/day/year.
Zeroing	Automatic zeroing on blank tube and hold blank facility for series of tests. Continuation test facility without the need for reblanking.
Internal Memory	Stores 500 previous readings with option to view logged results on screen, or download to computer.
USB Interface	USB 1.1 full-speed, bus-powered device. Software selectable between either emulation of a removable hard-drive or emulation of a serial device connected via a virtual COM port.
Power	3 x 1.5V 'AA' alkaline batteries or via USB interface. Power management system with variable length auto switch-off or 'continuous' operation.
Size	250 x 150 x 70 mm
Weight	985g
Test Tubes	For tablet reagents - 10 ml glass test tubes, 20 mm OD (PT 595).
Cell Holder	Multi-size tube holder accepts test tubes from 12 – 20 mm OD and centres the tube for optimum optical performance.

GENERAL PHOTOMETER OPERATION

The photometer is controlled by a simple intuitive menu system.

- The highlight indicates the active line or section of the screen.
- The **↑** and **↓** keys move the highlight through the menu choices.
- The **←** and **→** keys allow selection of options.
- The flashing cursor in the 'Options' menu at the bottom of the screen indicates the action which will occur if the **[OK]** button is pressed.

Operating Modes

The photometer has two distinct operating modes - the **PHOTOMETER** mode and the **SYSTEM** mode.

The **PHOTOMETER** mode is the normal operating mode for taking photometer readings. This mode is engaged automatically when the instrument is turned on by pressing the **⏻** key.

In order to conserve battery life the photometer will switch off automatically after use. The switch off period is five minutes in normal use, but may be adjusted in **SYSTEM** mode.

The **SYSTEM** mode is used to set the system options. This mode is engaged when the photometer is turned on using the key and then selecting 'System' using the **←** and **→** keys and pressing **[OK]**.

Scroll through the menu box to view all the options available.

System - Quick Start

When the instrument is first used, the **SYSTEM** mode should be used to set the preferred operating options :-

- Use the **↑** and **↓** keys to scroll through the features.
- Use the **←** and **→** keys to select the options.
- Press **[OK]** to accept the selections and return to **PHOTOMETER** mode.
- Select the language required from English, French, German, Spanish or Italian.
- Select the display units required from mg/l or ppm.

- Set the sample number option to 'On' to allow the entry of a sample number during normal photometer operation.
- Set the sample increment option to 'On' to automatically increase the sample number.
- Set the dilution factor to 'On' or 'Off'. If the dilution factor option is set to 'On', the instrument will allow the entry of a numerical factor which will be used in the calculation of the result to be displayed on the instrument.
- Select the preferred date format. The date may be shown in either Date/Month/Year or Month/Date/Year.
- To change the date and time, select the date and time line then key in correct setting using the numeric keys. To correct an error, use the ← and → keys to move the cursor then key in the correct data.

System - Full Options

The Soil Test 10 features a wide range of options which may be explored at leisure to get the best from the instrument. An explanation of the application of these options is as follows :-

View Log

The photometer has an internal memory which can hold up to 500 test results. Once the memory is full, each new result overwrites the oldest entry.

Select 'View Log' to view stored results on screen. The ↑ and ↓ keys may be used to scroll through the list of stored results. The 'Options' menu offers several choices.

Select 'Clear' to empty the memory. Confirmation is requested to avoid accidentally erasing the data. Select 'Exit' to return to **SYSTEM** mode. Select 'Download' to transmit stored data to a PC. This option only appears if the USB mode is set to 'COM Port'. Refer to 'Interface Connection and Data Memory' for further information.

Back Light

The graphic display features a backlight to enhance the display contrast. This may be switched off to conserve power when working on battery power.

Language Options

The photometer can be operated in a number of different languages. When a particular language is selected, the test names and operating commands will appear in that language. Certain tests and unit options are provided in accordance with the conventions of particular countries and are only available when the photometer is switched to the language concerned.

Sample Number

A unique number may be associated with each result record to identify it in the log. If Sample Number 'On' is selected, the user is offered the choice of entering a number of up to 10 digits for each sample reading. If this function is set to 'Off', a sample number is automatically allocated.

Sample Number Increment

The sample number increment option may be used to determine whether the instrument does or does not automatically increment the sample number after each test. Incrementation of the sample number may be used when the instrument is used for carrying out a series of similar tests. Alternatively it may be preferable not to increment the number if typical use involves carrying out a number of different tests on the same sample.

Dilution Factor

When samples are out of range for the test, a dilution procedure may be used. If the dilution factor option is set to 'On', the instrument will allow entry of a numerical factor which will be used in the calculation of the result displayed and stored in the log.

Date and Time

The instrument records the date and time of each reading taken and associates this with the data record in the log. To correct the date and time on the internal clock, select the date and time display line.

Date Format

The option of day/month/year or month/day/year date format is available.

Battery Level

A battery level indicator shows the power available. At least 3.0V is required for successful operation of the instrument.

Time-Out

As a power-saving measure, in normal use, the photometer automatically switches off five minutes after the last key is pressed.

The photometer may be switched to 'Long' time-out which allows 15 minutes before shut-down or 'Off' which allows continuous use. This is particularly useful when powering the instrument through the USB interface.

USB

The USB interface allows communication between the instrument and a PC. There is a choice of two operating modes – Hard Drive and COM Port.

In **Hard Drive** mode, the instrument appears as a removable hard drive when connected to a PC. No additional software is required on computers running Windows 2000, ME or XP. A driver to use this option with Windows 98SE is available from Palintest Technical Services Department.

In **COM Port** mode, the instrument behaves as if connected to the PC serial port via RS232. This allows backwards compatibility with software written for earlier models of Palintest instruments. In this mode, the PC requires installation of a USB virtual COM Port driver, available from Palintest Technical Services Department.

See the section on 'Interface Connections and Data Memory' below for full instructions.

User Defined Tests

Users may wish to develop their own test methods and store the calibration data on the Soil Test 10. This will allow direct reading of user tests. The Soil Test 10 has the facility to store up to 30 user-defined calibrations.

To program user-defined calibrations :-

Turn the instrument 'ON', select 'System' menu and press **[OK]**. Scroll through the options to the USB entry and make sure the option is set to 'Com Port'.

At the PC, open the HyperTerminal connection for the 7500 (apply to Palintest Technical Department to receive a disk containing virtual comport drivers for installation to PC).

At the instrument, in the 'System' menu, select 'Edit User Defined Tests' and press **[OK]**. The instrument will display the tests already downloaded, or show 'LIST EMPTY'.

In the 'Options' menu, select **[Add]** to add a new test, or **[Edit]** to edit the test which is currently highlighted. Change the highlighted test with **↑** and **↓** keys. Press **[OK]**.

The instrument displays a message box instructing the user to download the new or edited test file.

At the PC, download the calibration file from HyperTerminal using 'Transfer', 'Send Text File' and select the file to be downloaded.

The instrument will check the downloaded data. If it is acceptable, it will display a message box 'Accepted' over the downloaded data. If there are errors in the file, a list of errors will be displayed. The user should edit the calibration file to correct the errors then re-send it.

Press **[OK]** to accept the test. The instrument will change to the 'User Test List' screen (See 3), with a summary of the test displayed. Press **[OK]** to accept the test and write to memory. Select **[Cancel]** at any time to reject the calibration.

The format of the user calibration file is as follows :-

The file must start with 'USER CALIBRATION' and end with 'END'.

Test Number must be between 900-929 (30 tests).

Test name - up to 18 characters.

Units - must be one of the following - mg/l, ppm, mmol/l, μ mol/l or g/l.

Wavelength - must be one of the following – 450 nm, 500 nm, 550 nm, 570 nm, 600 nm or 650 nm.

Chemical symbols - up to 8 characters.

Data pairs - up to 10 pairs of data in the form :-

ABSORBANCE x.xxx, CONCENTRATION

(Concentration may be up to five digits).

An example is shown below :-

USER CALIBRATION

900

Chlorine

mmol/l

500nm

Cl₂

0,0

0.174,0.50

0.481,1.50

0.733,2.50

0.854,3.00

1.022,4.00

1.086,4.50

1.187,5.00

END

Error Messages

The photometer will display an error message in the unlikely even of malfunction. These error messages are mainly designed to assist service staff in diagnosing instrument faults. In the event of an error message appearing on the photometer display, contact Palintest Technical Services Department for advice.

Error messages are coded 1 – 10. Errors 1, 2, 3, 4, 5 and 6 are internal self-monitoring checks. In the first instance, the user should change the instrument batteries. If the error message still appears, it indicates a potential electronic fault with the instrument.

Errors 7, 8, 9 and 10 relate to blanking in the instrument. In the first instance, the user should check operating technique and sample clarity. If these are in order then these errors indicate a fault in the instrument optics.

Photometer Upgrade

It is now possible to upgrade the photometer with new test calibrations using a computer system. This will ensure that users can always keep the instrument up-to-date with the latest tests. Updates for the photometer can be supplied on request via e-mail from sales@palintest.com. No special computer software is required. Full instructions will be supplied with the upgrade data.

Guarantee

Palintest photometers are guaranteed for a period of one year from the date of purchase, excluding accidental damage or damage caused by unauthorised repair or misuse. The guarantee specifically excludes damage caused by water or by ingress of chemical solutions. Should repair be necessary, contact our Technical Services Department quoting the serial number shown on the back of the instrument. This guarantee does not affect your statutory rights.

INTERFACE CONNECTIONS AND DATA MEMORY

Stored data can be accessed by recall to the screen (see 'View Log'). Alternatively, data can be accessed using a PC :-

- Connect the instrument to the computer via the USB port, using any suitable USB cable, eg PT 746
- Turn the instrument ON and select **SYSTEM** mode from the 'Options' menu
- Scroll to 'USB' and select either 'Hard Drive' or 'COM Port'.

'Hard Drive' – Once this option is selected, simply turning the instrument ON while it is connected to a PC will cause an extra hard drive containing the instrument files to appear on the PC. The log of test results is in text file – 'Soil_log.txt'. The other files shown on screen contain calibration and operating systems for use when upgrading the instrument and should be ignored.

The log file can be copied from the instrument by dragging between windows and once copied can be opened with many text editors, word processors or spreadsheet programs.


Note that deleting this file from the instruments hard drive will clear the data from the instrument memory.

‘COM Port’ – Once this option is selected, data can be downloaded from the instrument to the PC :-

- Open the ‘Virtual COM Port – HyperTerminal’ window on the computer
- In the instrument **SYSTEM** mode, scroll to ‘View Log’ and select ‘Download’.



The data from the log will appear on the PC screen and can be transferred to Windows’ applications or printed as required.

Taking Test Readings

- 1 Press  key. The instrument displays the ‘Choose a Test’ menu box, with the last test program used highlighted as the active line.

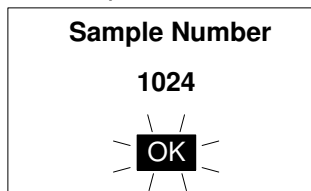
The cursor will flash on the [OK] symbol of the ‘options menu’ at the bottom of the screen.

Press [OK] to accept this program.

- 2 To choose a different test program, **either** use the  and  keys to scroll through the menu options, **or** use the numeric keys to enter the **Test** number of the desired test. The four most recently used tests are listed at the top of the ‘Choose a Test’ screen for convenience.

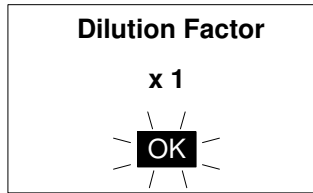
Press [OK] to accept the selected program.

- 3 If the sample number option is pre-selected, then the following display will appear, for example :-



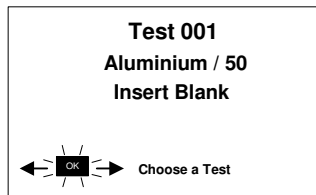
Enter or confirm the sample number (up to 10 digits), then press [OK].

- 4 If the dilution factor option is pre-selected, then the following display will appear :-



Press [**OK**] to accept the default value (x1, no dilution), or key in new dilution factor then press [**OK**].

- 5 The following display will now appear :-

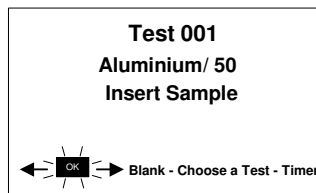


Place a **BLANK TUBE** in the test chamber, then press [**OK**].

NOTE: The instrument is designed to hold the blank setting as long as the instrument is switched on. This stage will be omitted when further tests are being carried out.

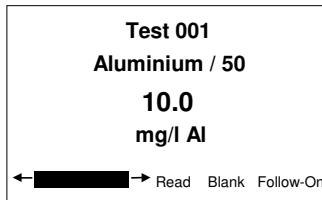
If the instrument is in continuous use mode, it is advisable to re-blank from time to time.

- 6 The instrument will be set automatically, and after a few seconds the following display will appear :-



Place **SAMPLE TUBE** in the test chamber, then press [**OK**].

7 The instrument will take the reading and display the result as follows, for example :-



The following symbols indicate the result is out of test range :-

Result is higher than range > >

Result is lower than range < <

8 The 'options menu' offers the choice to :-

'Choose a Test' - return to the menu of test programs and select another test

'Read' - read further sample tubes of the currently selected test

'Blank' - re-blank the instrument

POCKET TESTER INSTRUCTIONS

pH Meter Operating Instructions (PT 151)

Before First Use: Precipitation of the sensor electrolyte may cause white crystals to form around the cap. This is normal and does not affect the performance of the sensor.

Conditioning: Condition the sensor before use. Remove the transparent cap and fill with water to a height of 20 mm. Recap the sensor and soak (keep sensor and cap upright during this period) for one hour. This will activate the sensor and dissolve any crystals present. Rinse the cap afterwards.

Calibration: See page 52 for further details on making up buffer solutions for calibration purposes.

Select pH 7.0 buffer for general testing, select pH 4 for acidic and pH 10 for basic solutions. Press the on/off button to power on. Immerse sensor in 20 mm of buffer and stir gently. Wait for displayed value to stabilise at or near pH 7.0. Press the cal button to enter the calibration sequence. CAL will flash momentarily and then show a flashing default reading. To complete calibration, press hold/ent button to confirm (Ent). To abort calibration, press cal button to escape (ESC).

pH Testing: Remove the cap and press the on/off button to turn on the tester. Dip the sensor in at least 20 mm of test solution. Stir once and let the reading stabilise, note the value. Press hold/ent button to hold (HO) the reading. Annunciator will flash to indicate reading is in hold mode. Press hold/ent again to cancel (HC) the hold mode. Press the on/off button to turn the sensor off.

Maintenance: Rinse the sensor in tap water after use. In harsh samples, take readings as quickly as possible, then rinse the sensor immediately afterwards with deionised water to remove residues and prevent contamination between samples.

Useful Notes: To maintain sensor accuracy, use tester regularly or calibrate at regular intervals. For long-term storage, fill the cap with 20 mm of storage solution, and replace cap. This will keep the sensor conditioned and ready for its next use.

Changing Batteries: To remove batteries, lift up front battery cover and hold in position before lifting the two sides of the pocket clip. Remove old batteries and replace with new ones noting polarity as shown in the battery compartment.

Error Messages:

bAt – batteries are weak and need replacing.

Err – wrong buffer value (out of range) and/or sensor is failing, use fresh buffer.

Or/Ur – over or under range signal. Sensor may be contaminated /damaged/not fully immersed.

Warranty: this tester is supplied with a warranty against manufacturing defects for a period of one year from date of purchase

Calibrating with Buffer Tablets

Palintest rapid dissolving Buffer tablets are the quick modern way to buffer pH measuring instruments. The tablets provide colour-coded one-shot buffer solutions for use in standardizing pH meters and recorders.

Traditional practice has been to prepare a large volume of buffer solution and to store this for subsequent use. This practice runs the risk of contamination between use and of different pH buffers being confused with each other. In either event the result can be an incorrectly calibrated instrument.

Palintest Buffer tablets eliminate these problems by providing a quick, simple means of preparing one-shot buffer solutions. Each tablet makes 20 ml of buffer solution sufficient for all standard pH electrodes. pH 4, pH 7 and pH 10 Buffer tablets are available and the solutions produced are colour coded to avoid any mix up. After use the solutions are simply discarded to eliminate storage problems and risk of contamination.

The colour coding is as follows :-

- pH 4 Red solution
- pH 7 Yellow solution
- pH 10 Green solution

The solution colours act as pH indicators. Any severe user contamination of the solution can be detected by a change in the solution colour.

Instructions for Use

- 1 Fill the 10/20ml plastic tube (PT 526) to the 20 ml mark with deionised water.
- 2 Add one Buffer tablet of the required value and shake the tube until the tablet disintegrates.
- 3 Stand the tube for approximately two minutes to ensure the buffer is completely dissolved and to allow any insoluble particles to settle.
- 4 Check that the solution colour corresponds to the buffer value required.
- 5 Insert pH electrode into the tube and calibrate the meter in accordance with the instructions supplied with the instrument.

- 6 Remove electrode and rinse thoroughly in deionised water. It is important to rinse the electrode before immersing in buffer solution of a different value.
- 7 Discard solution, then rinse and dry tube.

Note: The buffer solution may be transferred to a separate container when dealing with unusual shaped pH electrodes.

Buffer Values

The pH value of buffer solutions varies with the temperature of solution. The precise buffer values given by Palintest Buffer Tablets at different solution temperatures are shown in the following table :-

Temperature/pH Chart

Temperature		Buffer Values (pH)		
°C	(°F)	4.01	7.00	10.00
0	32	4.01	7.12	10.33
5	41	4.01	7.09	10.25
10	50	4.00	7.06	10.18
15	59	4.00	7.04	10.11
20	68	4.00	7.02	10.05
25	77	4.01	7.00	10.00
30	86	4.01	6.99	9.95
35	95	4.02	6.98	9.92
40	104	4.03	6.98	9.88
45	113	4.04	6.97	9.85
50	122	4.06	6.97	9.82
55	131	4.07	6.98	9.80
60	140	4.09	6.98	9.77
70	158	4.12	6.99	9.73
80	176	4.16	7.00	9.69
90	194	4.20	7.02	9.66
Solution Colour		Red	Yellow	Green

For precise calibration the temperature of the solution should be measured and the meter standardised against the appropriate value.

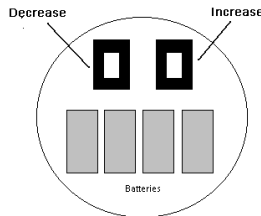
CONDUCTIVITY SENSOR OPERATING INSTRUCTIONS (PT 159)

Operating Range: 0 - 1990 $\mu\text{S}/\text{cm}$

Resolution: 10 $\mu\text{S}/\text{cm}$

Before First Use: Soak sensor for two minutes in alcohol to remove oils. Rinse in clean water.

Calibration: Remove the cap and unscrew the top battery compartment cover (the interior is shown below) :-



Press the On/Off button to turn the meter on.

Immerse the sensor in a calibration solution (PT 142/7) and allow the reading to stabilise.

Use the increase or decrease buttons to adjust the displayed value to coincide with the standard solution.

Using the Sensor: Remove cap and press the on/off button on the keypad to turn the meter on. Immerse the sensor in about 20 mm of the test solution. Stir once and let the display stabilise, note the value. Press the hold button if you wish to hold the reading. Press again to release. Press the on/off button to switch the meter off.

To avoid cross contamination between samples, the sensor should be rinsed with deionised water between uses.

Recalibration: For optimum performance, recalibrate the sensor regularly. Weekly recalibration is recommended if the sensor is in constant use. Clean the stainless steel electrodes by periodically washing them in alcohol for 10 - 15 mins. Rinse with water after each use.

Electrode Replacement: The electrode itself is replaceable. Please contact Palintest for information on how to replace the electrode.

Warranty: This tester is warranted to be free from manufacturing defects for six months.