PROJECT REPORT No. 322

FIELD ASSESSMENT OF P & K PLANT TESTING FOR WINTER WHEAT

OCTOBER 2003

Price £3.50

PROJECT REPORT No. 322

FIELD ASSESSMENT OF P & K PLANT TESTING FOR WINTER WHEAT

by

B FREER

Morley Research Centre, Morley St Botolph, Wymondham, Norfolk, NR18 9DB

This the final report of a 40 month project that started in September 1998. The work was funded by a grant of £37,967 from HGCA (project 1652)

Contents

Abstract
This project set out to assess the practicality of using the on-farm plant testing procedures for P & K status of wheat developed at Rothamsted. The procedure was found to be straightforward and gave a reasonable indication of nutrient status. Its use on-farm would be best utilised in conjunction with the standard soil testing method as an interim check on nutrient availability. There is an opportunity on many farms with indices above 2 for P and K to run down reserves if monitoring is done regularly using plant testing in conjunction with soil analysis.

Summary

The Soil Index System can be likened to a battery power indicator. A low reading does not necessarily mean the machine will not run it merely shows that the storage capacity is low. Soil sampling provides the farm with the information about how much plant food is available.

Plant testing tells you how much the plant has taken up. The problem with plant testing is that nutrient concentrations are not stable in the plant and change during the growing season and vary with which part of the plant is tested. Recent work at Rothamsted found that plant P and K concentrations were most stable in the youngest fully emerged leaf between GS 31-39.

Plant testing provides reassurance that the plant is receiving enough nutrients. On-farm testing provides growers with a quick test to complement soil sampling. The process of sampling and testing for phosphate (P) and potash (K) status in the wheat plant on-farm is straightforward and does not require knowledge of chemistry. It can be done with a minimum of equipment in a domestic environment. The main issue is one of time. The perception of it being a time consuming task best left to a laboratory can only be decided by an individual. Considering the capital outlay for a RQflex meter, it could be argued that it would be most appropriately used by an agronomist, servicing a group of farmers rather than by individual farmers.

This project examined the practical aspects of on-farm testing. HGCA has funded a number of related projects examining other aspects of this technique including its use in winter oilseed rape.

Introduction

The farming community has been raised on the soil index system for assessing the availability of P, K and magnesium (Mg) to crops (see DEFRA RB 209). This system provides fertiliser recommendations based on the soil availability of each nutrient and the requirements of each crop.

Soil testing indicates the potential availability of a nutrient, but there is no guarantee that all of the nutrient will find its way into the plant. The weakness of soil testing is that critical concentrations of available soil P and K for maximum grain yield depend on soil type and critical values for individual fields are not known. The critical value indicates the level below which the plant will be deficient in the nutrient and more than a 5% reduction in maximum grain yield is likely.

Plant testing does not suffer from this drawback, but until recently critical plant P and K concentrations in wheat (for maximum yield) were not known for UK conditions. Conventional plant tests based on total nutrient concentrations in plant dry matter are also far from ideal as critical concentrations change with plant growth stage and are affected by interactions with other growth factors. Recent work by ADAS and IACR-Rothamsted funded by HGCA (see HGCA Topic Sheet 19) established critical dry matter values for P and K in winter wheat and developed new plant tests suitable for on-farm use based on phosphate and potassium concentrations in plant sap.

The aim of this project was to build on the work done by Rothamsted/ADAS to develop a practical on-farm test for P and K that will supplement the standard soil tests and give the grower more confidence and reassurance about the state of the crop in relation to these two important nutrients.

1. To develop a practical on-farm method to optimise the management of phosphate and potassium in cereals in order to minimise fertiliser costs.
2. To compare soil and plant analysis for diagnosing the adequacy of phosphate and potassium supply.
3. To compare different plant tests and to validate new on-farm methods under field conditions.

Methods

Soil and plant samples were collected and analysed for potassium and phosphorus contents from sites in East Anglia in 1999, 2000 and 2001.

Tests in project

Soil available P – lab test	Soil available K – lab test
Leaf %P – lab test	Leaf %K – lab test
Shoot Pi – sap test on-farm with RQflex meter	Leaf K – sap test on-farm with RQflex meter

Experimental sites

In 1999, five fields with known variations in soil available phosphate and potassium concentrations were identified at Stanaway Farm in Otley, Suffolk, by soil mapping in 1997 and 1999.

In 2000, samples were taken from 19 sites with a range of soil types. The sites chosen were fields where soil mapping indicated variation in P and K status. There were selected in cooperation with Profarma in Norfolk, Suffolk and Cambridgeshire.

In 2001, due to the difficulties caused by the Foot and Mouth outbreak sampling was restricted to fields at Morley and Otley.

Within each field, $1m^2$ quadrats were randomly selected from within areas where soil mapping indicated differences in soil nutrient status. These were then marked and all soil, shoot, leaf and dry matter samples were taken from these areas.

Soil samples

From each individual quadrat, 15 10cm-deep soil cores were taken at random and bulked in February, prior to nitrogen fertiliser application. Soil was air dried, crushed with a pestle & mortar and put through a 2mm sieve. Soil was then sent for testing at Rothamsted (1999) or ADAS (2000/01) by the 'Olsen P' method for phosphate which involves extraction with a solution of sodium bicarbonate and the Extractable K method (K ex) for potassium using ammonium nitrate solution.

Shoot & Leaf samples

From each quadrat a representative sample of the expanded flag leaf from the main stem were collected at GS 39. 70 whole shoots were also collected at random before 10am to minimise variations in tissue water concentration. The whole shoots were then randomly split up as follows:

1. Shoot P, lab test -- 5 whole stems
2. Shoot Pi, on-farm test (RQflex) -- 5 whole stems
3. Leaf %P, lab test -- 10 flag leaves
4. Leaf %K, lab test -- 10 flag leaves
5. Leaf K, on-farm test (RQflex) -- 10 flag leaves

Two samples per quadrat were tested by each method to improve confidence in the results. All stems and flag leave samples were placed immediately in sealed polythene bags, with air expelled and labelled.

Samples for tests 2 and 5 were placed in a cool box at the time of collection and then transferred to a freezer as soon as possible. Samples for tests 1, 3 and 4 were also stored in a cool box during transit and then pre-dried in a microwave oven for 2 and 5 minutes to cease enzyme and then dried in an oven100º C for 24 hours, ready for laboratory testing by ADAS Laboratories.

On-farm testing equipment

<u>The RQflex meter</u>

The RQflex meter is a small portable reflectometer which gives concentration figures in mg/l for phosphate ($P_4O_3^-$) and g/l for potassium (K^+). For phosphate analysis, the method is similar to the soil test in that it measures phosphomolybdenum blue (PMB) reflectometrically. The potassium test also measures the cation reflectometrically with an orange-coloured complex. All chemical reagents for these tests are bonded to plastic test strips specific for each nutrient.

The testing equipment was originally designed for the testing of waste-water, soils, fertilisers and food, and the potassium test was designed for drinking, mineral, industrial and waste-water and soil. See Plate 1.

The equipment was checked according to given instructions with standard solutions of phosphate and potassium.

Further description and testing of this equipment was undertaken in HGCA Project OS58 (Plant and soil testing to assess the adequacy of phosphorous supply to winter oilseed rape).

The RQflex is manufactured by: Merck, 64271 Darmstadt, Germany and costs £426.93 + VAT, the test strips cost £41.73 + VAT for a pack of 50 strips.

Supplier: Merck Ltd, Merck House, Poole, Dorset, BH15 1TD.
Tel: 01202 669 700, Fax: 01202 665 599 web: http://www.merckeurolab.ltd.uk

Results

Sample collection

The bulked soil sample normally comprised around 1kg of soil, which represented an entire field. It is therefore essential that the soil collected is an accurate and representative sample of the field. The normal procedure for soil sampling is to take at least 25 soil cores in a 'W' shape across an entire field. These are normally bulked together and mixed thoroughly. A sub-sample of this mixture is then used in the laboratory testing. Points to remember when soil sampling are:

- Sample to a consistent depth (normally around 15 cm for arable soils)
- Avoid headlands, gateways, old hedgerows or any other irregular features
- Discard plant debris.
- Sample at the same time of the year because large variations in nutrient values have been observed. Values are expected to be higher in early spring than in the autumn as a result of biological activity and chemical weathering over winter
- Avoid taking samples within four weeks of nitrogen fertiliser applications as this can influence the analysis.

As with all sampling procedures, the results are only useful if the samples are representative of the population. This is accepted when taking soil samples and the same rules apply when taking plant samples. However with plant sampling there are additional factors to consider:

- Samples for on-farm sap testing need to be taken at the same time of day to avoid fluctuations in tissue water concentration, ideally before 10.00 am.
- Samples for sap testing must be kept cool to avoid transpiration losses during transit.
- Sample between GS 31 and GS 39 when the critical values were found to be most stable.
- Avoid taking samples when the crop is under stress from water logging /drought etc.

The time taken to collect plant material is less than that for collecting soil samples.

Sample storage and preparation for testing

With soil samples there is little preparation necessary apart from thorough mixing of the soil, sub sampling and posting to a laboratory for analysis. However for plant samples additional processing is required to stabilise the samples prior to testing. This is not onerous but does need to be completed as soon as possible after sample collection.

Once the plant material is cut for sap testing it needs to be kept cool. Placing flag leaves in bags and putting them in a cool box was straight forward. However as samples were collected at GS 39, handling large amounts of whole stems was less easy as they were too large to fit in the domestic cool box. This would restrict the number of samples done at one time unless a larger receptacle was used.

On return to the farm, flag leaf and shoot samples for the on-farm tests were put in a domestic deep freezer. Freezing the plant material ruptures cell walls and makes tissue water easier to extract.

Flag leaves destined for laboratory analysis needed to be stabilised as the previous project (HGCA Project Report 137) found that transformations of organic-P to inorganic-P (Pi) occurred when dried in a conventional oven over a four hour period. Samples for this test were consequently heated in a domestic microwave oven. A glass of water was put in the microwave oven to avoid over-heating, as the first attempt resulted in a damaged microwave. Leaves were not a problem, but stems had to be chopped up which took up to 5 minutes a sample and care had to be taken to avoid charring of the sample. They were then dried for a further 4 hours in a conventional laboratory oven at 100º C in order to ensure they were completely dry. These samples were then dispatched to the laboratory for milling and analysis.

On-farm testing procedure

This process can be done in a domestic setting (i.e. the kitchen – with prior approval!) and does not require expensive laboratory equipment apart from the purchase of the reflectometer (£500).

Apart from the spectrometer, a supply of distilled water (as used in steam irons), a supply of syringes and an apparatus to squeeze sap is all that is required. A plastic screw press was used for the latter. The size of the flag leaf sample in this project proved to be too small for easy sap extraction using a syringe. It is advisable to obtain a larger number of flag leaves as this will make sap extraction easier unless a screw press is available.

The on-farm test was the most time consuming method used in this project although results were more quickly available than sending the samples away and waiting for the results. (Step by step guidelines are given in the Appendix and also in HGCA Project Report No. OS58).

Time and motion study

The time and cost of the different testing methods was examined in 1999 and 2000.

The cost per test for all methods of analysis is itemised below. These costs are based on the fact that all sampling would take on the 'W' format throughout an individual field and that 25 samples would be taken per field. The time element to walk the field and collect the samples has not been taken into consideration, as it is believed that for all analysis techniques, this would amount to the same amount of time being spent by either the farmer or agronomist. As a common cost it is discounted from the following tables.

Table 1: Analysis cost.

	Lab test	On-farm test	Cost/sample
Soil P & K (bulked sample)	✔		£10.00
Leaf P (dry matter)	✔		£8.00
Leaf K (dry matter)	✔		£8.00
Leaf K (RQ Flex Meter)		✔	£2.50
Shoot Pi (RQ Flex Meter)		✔	£2.50

Notes:

- The cost of the RQflex meter has not been taken into consideration. (c. £427 + VAT)
- The chemical analysis strips for the RQflex meter are purchased in quantities of 50, and have only been calculated as 2 strips/test, at a cost of £1/strip.
- Each sap test took 30 minutes to complete but a labour charge has not been added.
- A charge of £0.50 has been included in the RQflex calculation to cover the cost of disposable items such as distilled water.
- No cost for the purchase of laboratory equipment such as beakers has been included.
- No charge has been included for postage of samples to the laboratory.

Plant nutrient analysis

Critical values for wheat plants were determined by Barraclough *et al.* and presented in HGCA Project Report 137. Various tests were discussed in this report. The most reliable results were obtained from measuring total P concentration as % of plant dry matter (%P) in the youngest fully expanded leaf (leaf 1) (laboratory test on flag leaves in the present project) and whole shoot Pi (millimolar, mM) as inorganic orthophosphate concentration in plant tissue water (Piw) (on-farm test with RQflex in the present project).

Phosphate

Soil P is expressed as Olsen P (mg/l) with the critical concentration value shown in Figure 1 being that of the minimum of ADAS Index 1 (10 mg/l). This is the point at which supply is deemed either deficient (below 10mg/l) or adequate (above 10 mg/l). There were only seven samples that indicated deficiency, i.e. less than 10 mg/l, and these were only marginally deficient at just below 10 ppm. This was despite the areas being chosen as likely to be deficient on the basis of previous soil sampling. This is not therefore surprising as the Index system is a wide band which has to account for a broad range of soil types.

Leaf %P in flag leaves at GS 39 was determined in the laboratory (Fig. 2). Ten samples fell below the lower limit of the critical range (0.28%), but many more were below the mean critical value of 0.32% (Figure 2). Most (all except 7) soil samples indicated that there was adequate supply of P. This was confirmed by both methods of plant testing.
The field-based on-farm plant test indicated that seven samples were below the lower limit of the critical range (4 mM) (Fig. 3). The soil samples that indicated a potential shortage of P did not correspond well with the plant tests. Laboratory samples indicating plants below the critical value did not correlate with the on-farm test. Generally speaking, the soil tests indicated that most sites had adequate P and this was best confirmed by the on-farm plant test. The traditional dry matter plant test seemed to indicate a much greater frequency of deficiency.

Potassium

Soil K is expressed as extractable K (K ex) with the critical concentration shown in Figure 4 being the minimum of ADAS Index 1 (120 ppm). Basically, none of the soils were K deficient. Laboratory determination of % K in the flag leaf (Figure 5) indicated that just two samples were below the lower limit of the range (1.6%), and 13 samples were below the mean critical value (1.9%). However, the on-farm test indicated no sample was below the mean critical value of 150 mM, concurring with the soil tests (Figure 6). However some of these values are unusually high suggesting that the samples had dried out prior to testing. Generally speaking, the soil tests indicated that most sites had adequate K and this was best confirmed by the on-farm plant test.

The raw data is in the Appendix.

Discussion

A recent survey by MAFF has indicated that only 13% of arable soils are Index 0 for P and 28% for K. Most growers apply P & K fertiliser regularly, either annually or rotationally. Growers have concerns that firstly, if they don't (apply fertiliser annually) yields will tumble and secondly that if they allow nutrient levels to deplete to Index 1 or 0, it will cost a fortune to raise the soil nutrient status again.

Work at Morley (sandy loam over chalky boulder clay) examining the rotational application of P & K in the late 1970's and early 80's showed that in a nine-year period, phosphate (P) levels fell from 21 mg/l to 9 mg/l (Index 2 to Index 0) where no P or K fertiliser had been applied. In contrast, potassium (K) levels fell from 115 mg/l to 70 mg/l (still within Index 1). Yield levels and thus nutrient off-takes were considerably lower then than today, but these data indicate how the soil reserve declined and were used as part of the argument for triennial applications of P & K by Morley. A yield reduction of around 10% was observed at the end of this nine-year period where no P or K had been applied (Figure 7). In many fields today, soil nutrient indices are well above Index 2 and it is in these conditions that short to medium term savings can be made in P & K fertiliser inputs.

Regular soil testing every five years is generally recommended in the industry. The consistent use of the same analytical technique is also recommended as different laboratories use different systems and this can be a major source of variation in the veracity of the result. The use of plant testing is designed to supplement soil testing not replace it. It is important to emphasise that soil testing and plant testing are measuring two different things. Soil tests indicate the potential supply of nutrients available, whilst plant tests indicate how much the plant has taken up. They cannot therefore be compared directly as plant uptake is influenced by water supply, rooting and soil conditions. HGCA Project Report No.137 established, for the first time, critical plant concentrations of P and K for UK wheat crops. These critical levels, below which a reduction in yield is likely, were shown to be most stable during stem elongation and thus provided a timeframe when testing the plant's nutrient level which would give a reliable indication of sufficient nutrient availability.

Phosphate

This project has shown that plant testing concurred with soil testing in that plants growing in soils with an Index of 1 or more were being supplied with adequate nutrients. Seven out of 60 soil samples, i.e. 12%, indicated crops were growing in Soil Index 0 and would therefore be likely to show a yield response to P fertiliser. Plant testing using flag leaves (analysing for % P in dry matter in a laboratory) suggested that a greater number of samples (nine) were below the suggested critical value range of 0.28 – 0.38 %, i.e. 15% of the samples. Plant testing using Pi in whole shoots (using the field based technique) suggested seven samples were below the critical range 4-6 mM Piw, i.e. 12% of the samples.

Potash

Soil testing indicated that none of the soils tested were below the critical value. Laboratory analysis of flag leaves suggested two samples (3%) were below the lower limit of the critical range (1.6 – 2.5 %K), but on-farm testing concurred with the soil analysis, i.e. all plant samples were adequately supplied with K.

For the majority of samples, plant tests confirmed that there was an adequate supply of nutrients, i.e. plant tissue contained adequate nutrient for maximum yield. It is therefore concluded that plant testing provides a good indication of nutrient supply, and that in cases where plant testing suggests otherwise confirmatory soil sampling is advised.

Practicality of plant testing

The process of sampling and testing for P and K on-farm is straightforward and does not require knowledge of chemistry. It can be done with a minimum of equipment in a domestic environment. The main issue is one of time. The perception of it being a time consuming task best left to a laboratory can only be decided by an individual. Considering the capital outlay for a RQflex meter, it could be argued that it would be most appropriately used by an agronomist servicing a group of farmers rather than by individual farmers.

Acknowledgements

The author wishes to acknowledge the advice and guidance given by Peter Barraclough, IACR Rothamsted; Miss Teresa Rushbrook and Mr Christopher Key who carried out the field sampling and plant tests at Morley Research Centre and were funded by the Chadacre Trust. The author would also like to acknowledge the participation of ProFarma in finding sites suitable for the test and the co-operating farmers involved.

Appendix

Instructions for the determination of P & K levels in plants using on-farm tests.

<u>Equipment required</u>

RQflex meter
Analytical test strips specific for P or K
Reagent (supplied with the strips)
Distilled water (car battery or steam-iron water is suitable)
Screw press for extracting sap
Syringes (5 and 50 ml) for extracting and diluting sap

<u>Checking procedure</u>

Follow the instructions that come with the RQflex meter to calibrate the machine for each test.

<u>Sample collection for both P and K, leaves and shoots</u>

For samples to be analysed by a laboratory:

Collect a representative sample of the youngest fully expanded main stem leaf between GS 32 and GS 39 (i.e. final leaf 3, 2 or flag leaf) for the analysis of phosphorus and potassium in dry matter by the laboratory method.

<u>For the on-farm tests</u>

Collect a sample of fresh whole shoots. Avoid collection of plant tissue that has recently been sprayed with agrochemicals or fertilisers (7 days). Ideally, therefore, samples should be collected prior to flag leaf fungicide application. Collect fresh samples before 10.00 am. Do not test crops suffering from drought. Ensure that the sample is representative of the field by following the standard guidelines for soil sampling. Place leaves or whole shoots in a plastic bag and put in a cool place such as a domestic cool box. As soon as possible, cut up the material into 1 cm lengths being careful to ensure that, in the case of shoots, the correct proportions of leaves to stem is maintained and place the sample in a labelled bag in a domestic deep freezer.

<u>Sample testing using the RQflex meter</u>

Remove the sample from the freezer and allow 15 minutes for it to defrost. Place the sample in a screw press and extract the sap. Alternatively, if a press is not available, pack the chopped material into a large (50 ml) syringe. Squeeze the sap into a clean container. Collect 1 ml of this green juice using a small syringe and make up to 30 ml with distilled water in a clean container. Test the resulting solution following the instructions that come with the machine.

Phosphate

Rinse the test vessel (from the phosphate test strip pack) with the pre-treated sample which has been diluted x 30, fill it up to the 5ml mark and then add ten drops of the reagent and swirl it around. Then press the start button on the machine to start the ninety-second countdown and at the same time place a test strip in the solution for two seconds. When the counter reaches five seconds the beeper sounds and at this point remove the test strip from the solution and shake off excess solution. Insert the strip into the strip adapter. The reading will appear after the time is up in mg/l P_4O^{3-}. The whole procedure from removing the sample from the freezer to analysis should be no longer than 30 minutes.

Record the reading from the meter expressed as mg/l $P_4O_3^-$. Firstly account for the dilution factor by multiplying by 30, then multiply the value by 0.011 to give mM Pi (inorganic P). The critical range is 4-6 mM. Values above 6 mM indicate that the plants sampled have an adequate supply of phosphorous, values below 4 mM that P supply is deficient.

E.g.: RQflex reading = 22

22 x 30 x 0.011 = 7.26 mM Pi

Potassium

Place twenty-five drops of K-1 reagent into one of the two mini-test tubes provided. Take a test strip out of the tube and immerse it in the pre-treated sample solution (diluted x 30) for two seconds, remove and shake off the excess moisture. Press the start button on the RQflex machine twice and it will begin to count down from sixty, at the same time put the strip in the mini-test tube with the K-1 reagent. At the end of the time remove the strip shake well and place in the strip adapter and press the start button again. After a few seconds the reading will be displayed in g/l K.

For potassium, the meter reading is expressed as g/l K+. To convert to mM Kw multiply the reading by the dilution factor (30) then by 1000; divide by 100 and multiply by 2.6. The critical value is 150 mM. Values above 150 mM indicate that the plants sampled have an adequate supply of potassium for maximum yield; below this K supply is deficient.

E.g.: RQflex reading = 0.44

$$\frac{0.44 \times 30 \times 1000}{100} \times 2.6 = 343.2 \text{ mM Kw}$$

Before proceeding to another test, always rinse the equipment thoroughly with distilled water to avoid contamination between samples.

HGCA publications on P & K:

Phosphorus and potassium requirements of cereals - HGCA Research Review No. 16 (1990)

Sulphur, phosphorus, potassium and copper - measuring crop needs, impacts on quality and options for management. Proc. HGCA R & D Conference (1994)

Plant testing to determine the P and K status of wheat - HGCA Project Report No. 137 (1997)

P and K assessment and fertiliser use - Proc. 6th HGCA R&D conference (1998)

Optimising P and K use on winter wheat: plant and soil testing - HGCA Agronomy Roadshows (1998)

Diagnosing P and K requirements of winter wheat - HGCA Topic Sheet No. 19 (1999)

Phosphate and potash fertiliser recommendations for cereals: current issues and future trends. HGCA Research Review No. 40 (1999)

Development of on-farm plant tests for phosphate and potassium in wheat - HGCA Project Report No. 224 (2000)

P & K fertiliser planning: using soil and plant analysis to plan fertiliser use - HGCA guidelines (2000)

P & K fertiliser management - HGCA interactive CD (2001)

Plant and soil testing to assess the adequacy of phosphorus supply to winter oilseed rape - HGCA Project Report No. OS58 (2002)

Figure 1. Soil Index of samples (Olsen P)

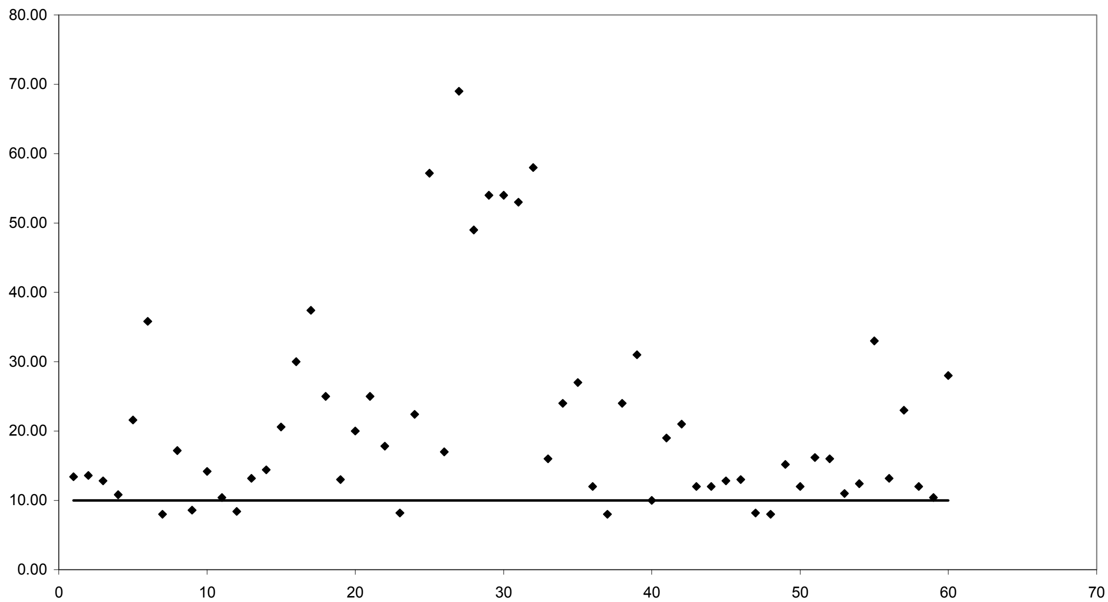


Figure 2. Leaf (1) % P in dry matter

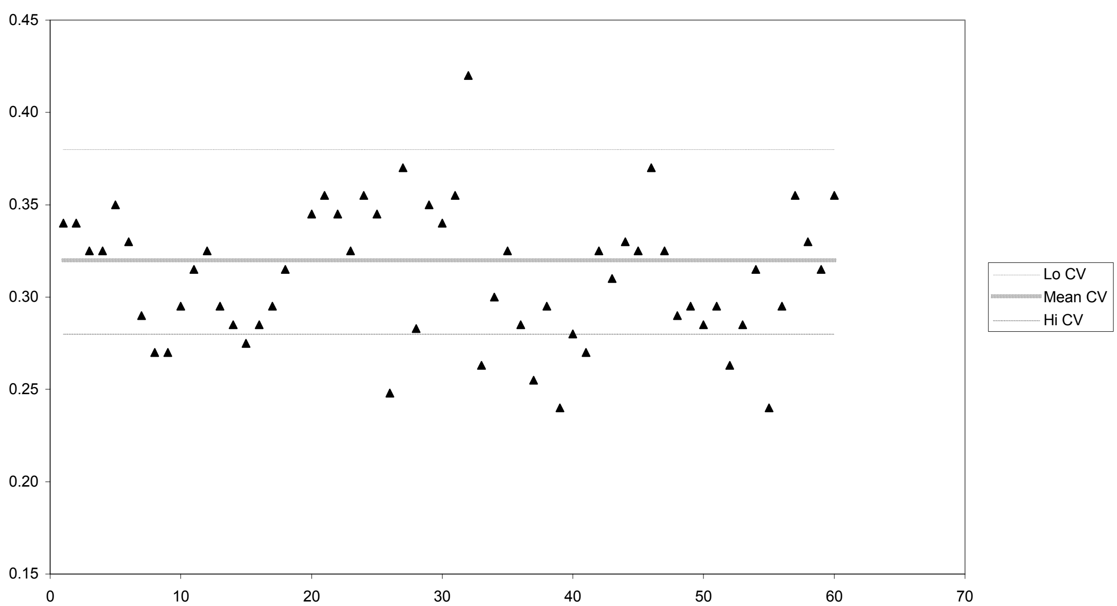


Figure 3. Field based Pi in shoot (mM)

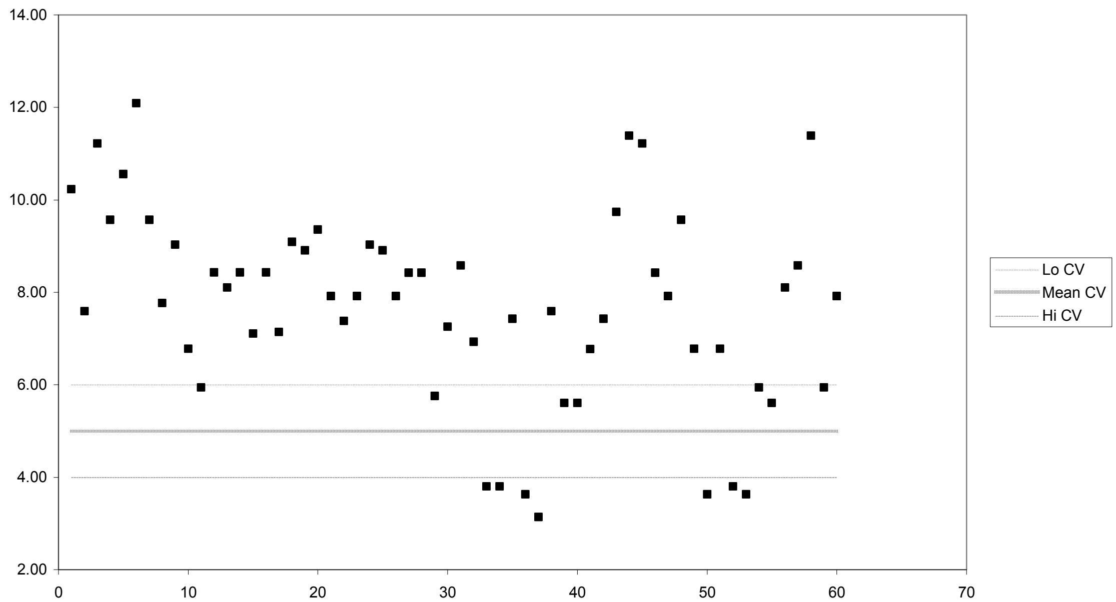


Figure 4. Soil K (K ex)

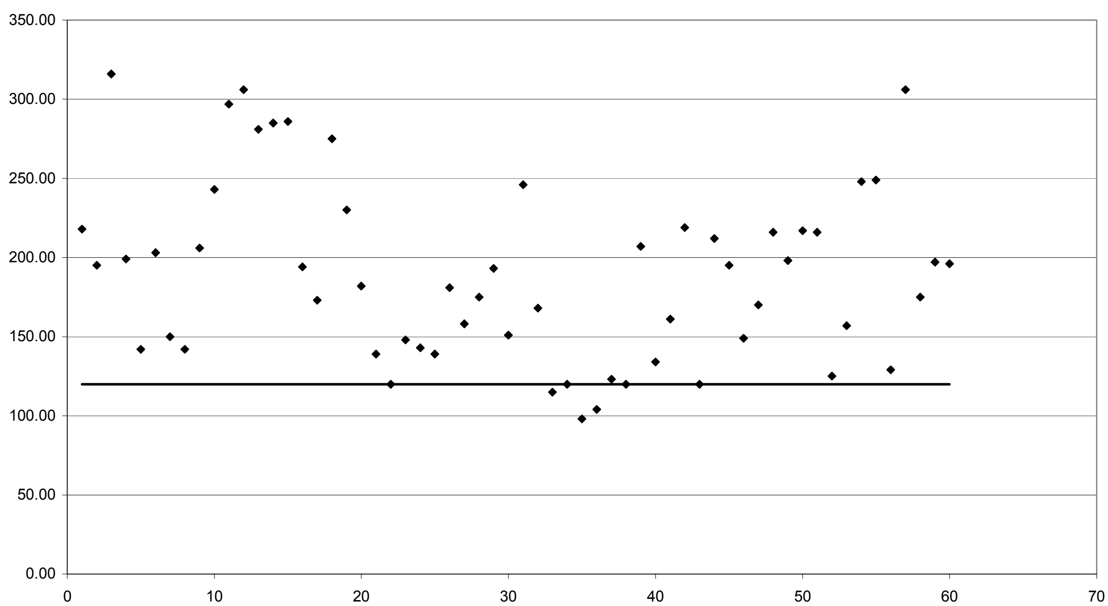


Figure 5. Laboratory determined K in Leaf (1) %

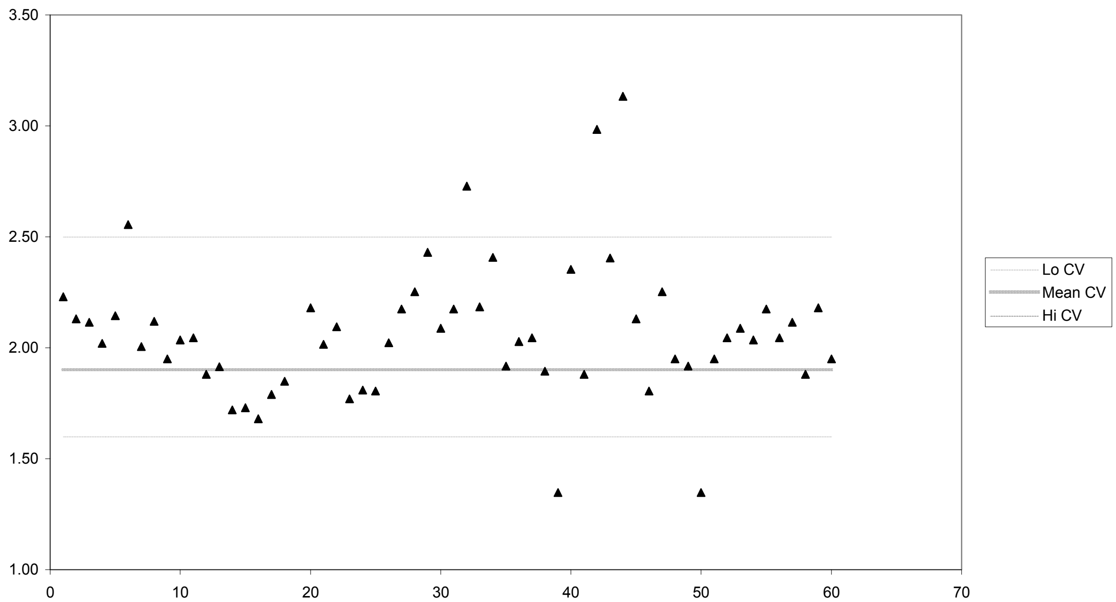
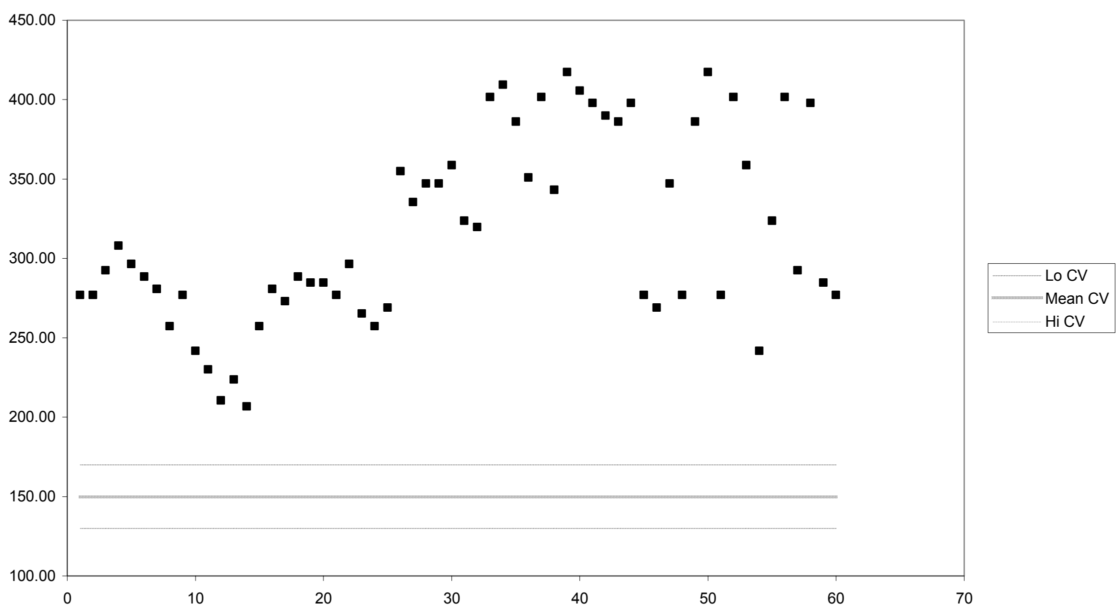


Figure 6. Field based K



Data

Sample	Soil P	Flag leaf Total P%	Shoot P (RQ Flex)	Soil K	Leaf K (DM)	Leaf K (RQ Flex)
1	13.40	0.34	10.23	218.00	2.23	276.90
2	13.60	0.34	7.59	195.00	2.13	276.90
3	12.80	0.33	11.22	316.00	2.12	292.50
4	10.80	0.33	9.57	199.00	2.02	308.10
5	21.60	0.35	10.56	142.00	2.15	296.40
6	35.80	0.33	12.09	203.00	2.56	288.60
7	8.00	0.29	9.57	150.00	2.01	280.80
8	17.20	0.27	7.77	142.00	2.12	257.40
9	8.60	0.27	9.03	206.00	1.95	276.90
10	14.20	0.30	6.78	243.00	2.04	241.80
11	10.40	0.32	5.94	297.00	2.05	230.10
12	8.40	0.33	8.43	306.00	1.88	210.60
13	13.20	0.30	8.10	281.00	1.92	223.60
14	14.40	0.29	8.43	285.00	1.72	206.70
15	20.60	0.28	7.11	286.00	1.73	257.40
16	30.00	0.29	8.43	194.00	1.68	280.80
17	37.40	0.30	7.14	173.00	1.79	273.00
18	25.00	0.32	9.09	275.00	1.85	288.60
19	13.00	0.00	8.91	230.00	-	284.70
20	20.00	0.35	9.36	182.00	2.18	284.70
21	25.00	0.36	7.92	139.00	2.02	276.90
22	17.80	0.35	7.38	120.00	2.10	296.40
23	8.20	0.33	7.92	148.00	1.77	265.20
24	22.40	0.36	9.03	143.00	1.81	257.40
25	57.20	0.35	8.91	139.00	1.81	269.10
26	17.00	0.25	7.92	181.00	2.02	354.90
27	69.00	0.37	8.42	158.00	2.18	335.40
28	49.00	0.28	8.42	175.00	2.25	347.10
29	54.00	0.35	5.76	193.00	2.43	347.10
30	54.00	0.34	7.26	151.00	2.09	358.80
31	53.00	0.36	8.58	246.00	2.18	323.70
32	58.00	0.42	6.93	168.00	2.73	319.80
33	16.00	0.26	3.80	115.00	2.19	401.70
34	24.00	0.30	3.80	120.00	2.41	409.50
35	27.00	0.33	7.43	98.00	1.92	386.10
36	12.00	0.29	3.63	104.00	2.03	351.00
37	8.00	0.26	3.14	123.00	2.05	401.70
38	24.00	0.30	7.59	120.00	1.90	343.20
39	31.00	0.24	5.61	207.00	1.35	417.30
40	10.00	0.28	5.61	134.00	2.35	405.60
41	19.00	0.27	6.77	161.00	1.88	397.80
42	21.00	0.33	7.43	219.00	2.99	390.00
43	12.00	0.31	9.74	120.00	2.41	386.10
44	12.00	0.33	11.39	212.00	3.13	397.80
45	12.80	0.33	11.22	195.00	2.13	276.90
46	13.00	0.37	8.42	149.00	1.81	269.10
47	8.20	0.33	7.92	170.00	2.25	347.10
48	8.00	0.29	9.57	216.00	1.95	276.90
49	15.20	0.30	6.78	198.00	1.92	386.10
50	12.00	0.29	3.63	217.00	1.35	417.30
51	16.20	0.30	6.78	216.00	1.95	276.90

52	16.00	0.26	3.80	125.00	2.05	401.70
53	11.00	0.29	3.63	157.00	2.09	358.80
54	12.40	0.32	5.94	248.00	2.04	241.80
55	33.00	0.24	5.61	249.00	2.18	323.70
56	13.20	0.30	8.10	129.00	2.05	401.70
57	23.00	0.36	8.58	306.00	2.12	292.50
58	12.00	0.33	11.39	175.00	1.88	397.80
59	10.40	0.32	5.94	197.00	2.18	284.70
60	28.00	0.36	7.92	196.00	1.95	276.90