PT108
Decision support software for the nutrient management of potato crops

A P Dahlenburg
South Australian Research & Development Institute

Know-how for Horticulture™

PT108

This report is published by the Horticultural Research and Development Corporation to pass on information concerning horticultural research and development undertaken for the potato industry.

The research contained in this report was funded by the Horticultural Research and Development Corporation with the financial support of the potato industry.

Cover Price $20.00

HRDC ISBN 1 86423 456 3

Published and Distributed by:

Horticultural Research and Development Corporation
Level 6
7 Merriwa Street
Gordon NSW 2072

Telephone: (02) 9418 2200
Fax: (02) 9418 1352

POSTHARVEST HORTICULTURE

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

REPORT No.: R/1/95

Horticulture Research & Development Corporation

Final Report (Project - PT108)

DECISION SUPPORT SOFTWARE FOR THE NUTRIENT MANAGEMENT OF POTATO CROPS

by

A.P. Dahlenburg
N.A. Maier

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Plant Research Centre
GPO Box 397
ADELAIDE SA 5001

Plant Research Centre
Waite Precinct Campus
Hartley Grove
URRBRAE SA 5064

TABLE OF CONTENTS

1. SUMMARY

INDUSTRY SUMMARY

1. A pilot computer software package has been developed which can be used to assist potato growers with the nutrient management of their crops for the production of high quality and market specific tubers.

2. The decision support software (DSS) package can be used by growers, agri-business and industry consultants to guide producers in crop nutrient management.

3. Recommendations for fertiliser applications are generated from soil test data for all the major potato production regions in South Australia with sensitivity to variety, fertiliser application method and tuber end use.

4. Plant tissue data is analysed by the program in relation to crop growth stage and the data for individual nutrients is graphically compared with the interpretation standards for that nutrient at that particular growth stage.

5. Previous and current tissue sample concentrations are plotted on the same graphical presentation to allow users to easily see trends in nutrient concentration in relation to the interpretation standards.

6. The software has provision to record data about other crop production and management factors.

TECHNICAL SUMMARY

1. A pilot decision support software package has been developed for the nutrient management of irrigated potato crops in South Australia.

2. The software has been developed to run on IBM and compatible computer systems and runs under the DOS environment.

3. The stand-alone compiled program has been developed from dBase IV, Clipper v5.2 and dGE graphics software.

4. The data obtained from research and development work with experimental planting's and crop monitoring over the previous 10 years or more has been incorporated into this program.

5. Crop monitoring work during the first 2 years of the project was used to provide additional information to help in fine tuning the recommendations.

6. Soil test interpretation is region specific and this package provides NPK fertiliser recommendations for all the major potato production regions in South Australia.

7. Soil analysis interpretation for other regions can easily be incorporated into the software provided the basic data for that region is known.

8. The soil test interpretation is sensitive to variety, soil type, fertiliser application method and tuber end use.

9. Tissue analysis data for up to 3 sampling times on the one crop can be entered into the software and the concentration for each nutrient will be assessed in relation to the desirable range at that point in the growth cycle of the crop.

10. For each nutrient, all tissue concentrations entered on the system for a particular crop are presented graphically in relation to the interpretation standards for easy visual assessment of nutrient concentration trends.

11. The tissue data for up to 10 crops/sites can be displayed on a single nutrient graph for easy comparison of data from different paddocks or growers.

12. The tissue interpretation module of the software has national significance and with little modification could be used for the analysis of potato crops throughout Australia.

2. RECOMMENDATIONS

1. Development of decision support software to assist producers in the nutritional management of potato crops should be continued following the successful development of a pilot system in this project.

2. The program should be developed with a national focus so that it will be relevant and useable across the whole of Australia.

3. Decision paths developed in this program should be used in any further developments as they have been proven to be reliable and accurate.

4. Particular aspects of the software which need further development are:

   4.1. Remove some of the redundant checking for the correct crop record.

   4.2. Simplify the crop selection procedure.

   4.3. Incorporate more recommendations into the tissue analysis module.

   4.4. Provide improved on-line help.

   4.5. Provide better hardcopy output for analysis and recommendations.

5. The software may be more saleable and user friendly if converted to operate in the Microsoft Windows environment. This would allow for mouse operation and provide a simple solution to the hardcopy problems associated with DOS programs.

6. The software developed has been used regularly by a small group in South Australia and found to be useful and reliable tool for assisting with potato crop management. Promotion should be an important part of any further development work.

3. TECHNICAL REPORT

Introduction

There has been an extensive research effort into potato production and marketing for more than 20 years and there has historically been a low adoption rate of any new technology developed. In the 10 year period from the early 80's to the early 90's the most significant research effort on potato crops in South Australia was in relation to crop nutrition and its impact on tuber yield and quality. Throughout that period, there were a large number of fertiliser experiments conducted in all the major potato production regions of the state and recommendations for fertiliser applications rates in relation to soil nutrient concentrations were developed. Concurrently data was collected on the critical levels of tissue nutrient concentrations in relation to maximising yield and tuber quality. In the later part of this period a large number of potato crops were monitored for tissue nutrient levels and the changes in these in relation to crop growth stage.

The information and recommendations arising from this research work was regularly extended to the industry through grower meetings and appropriate publications however, the adoption rate was low. One of the contributing factors to this slow rate of adoption are the large number of variables to be considered in the interpretation of any soil or tissue analysis results. Decision support software can be used to minimise this problem as it can handle a large amount of varying data so that it can be relevant for a large number of situations but present to the user only that information relevant to his situation. The manual interpretation of soil and plant test data for any particular grower has to be done on a one to one basis which is time consuming and often inconvenient which may also contribute to the low adoption rate.

There is a trend for an increasing number of producers to use the services of specialist consultants to provide crop management advice. In the future these consultants will be more reliant on decision support software and specialised data storage and retrieval systems to keep track of the crop data for their growing base of clients and provide timely and relevant advice. At the present time there is also a potato industry development officer (HRDC project) working with the industry in the South East of South Australia and this software can be of benefit in his work.

The aim of this project was to develop a pilot decision support software package to assist the potato industry with fertiliser application and crop nutrient status decision making. The package has been tested under a wide range of conditions and found to give recommendations consistent with those which would be made by the experienced R&D staff working on the project.

In developing the concepts for this decision support software package it was felt that it was not useful to develop a system which was only a once off an analysis system which requiring the input of either soil nutrient or petiole nutrient test results, provided an analysis and recommendations and then discarded the data. Our aim was to incorporate into the system data storage and retrieval procedures to allow a complete nutritional management picture for a particular crop to be developed and recorded as the season proceeded. It was also developed with the potential for easy expansion in

the future to include further modules like pest and disease management, irrigation scheduling and records etc.

The software was developed in 2 modules, one for soil nutrient analysis interpretation and a second for the interpretation of potato petiole nutrient composition.

Site and Crop Information

The soil nutrient interpretation module was the first to be developed and included other basic aspects of the program including the collection and filing of the crop identification data (Table 1.). This was necessary to create a crop record on the system for the retrieval of the data for particular crops for editing purposes, for selection in comparative analysis, particularly within the tissue test interpretation module and archiving and reviewing in later years. Other data input at this stage was basic data required for the soil and/or tissue interpretation modules to provide a reliable interpretation (Table 1).

TABLE 1. Basic Site and Crop Data

1.1 Site Identification Data
- Season
- Grower
- Paddock
- State
- Region (District)

1.2 Crop Information Data
- Variety
- End Use
- Crop Rotation
- Tillage System
- Fertiliser Placement
- Soil Type

Soil Test and Fertiliser Recommendations.

In the planning of this module all the results and fertiliser recommendations developed from specific fertiliser experiments within the different regions of the state over the previous 10 to 15 years were used. Over this time all the key factors in making a reliable fertiliser recommendation had been identified and were programmed into the software. The soil analysis data (Table 2.) is input to the software on a single entry screen (Figure 1.). The software summarises all these parameters in a horizontal bar graph format in relation to deficient, adequate and high zones (Figure 2.).

TABLE 2. Soil Analysis Data Input to the Program.

2.1 Soil Characteristics	
♦ Acidity (pH)	
♦ Organic Carbon	%
♦ Conductivity (Ec)	mS/cm
2.2 Major Nutrients	
♦ Phosphorus (P-Colwell)	mg/kg
♦ Potassium (K-Colwell)	mg/kg
2.3 Minor Nutrients	
♦ Copper (Cu-DTPA)	mg/kg
♦ Zinc (Zn-DTPA)	mg/kg
♦ Manganese (Mn-DTPA)	mg/kg
♦ Iron (Fe-DTPA)	mg/kg

Fertiliser recommendations are made for the 3 major nutrients (N,P,K), each being displayed on a single screen. The user can select to display all 3 recommendation screens sequentially or display only the screen for a selected nutrient. Each fertiliser recommendation provides the recommended application rate and is

accompanied by appropriate recommendations/notes on split applications, fertiliser types, timing of applications, application methods and impact on soil nutrient status. The fertiliser recommendation screens for nitrogen (N), phosphorus (P) and potassium (K) are shown in Figures 3,4 and 5 respectively.

Recommendations and/or warnings for low micronutrient analysis are not made within the current program.

FIGURE 1. - Soil Nutrient Analysis Data Input Screen.

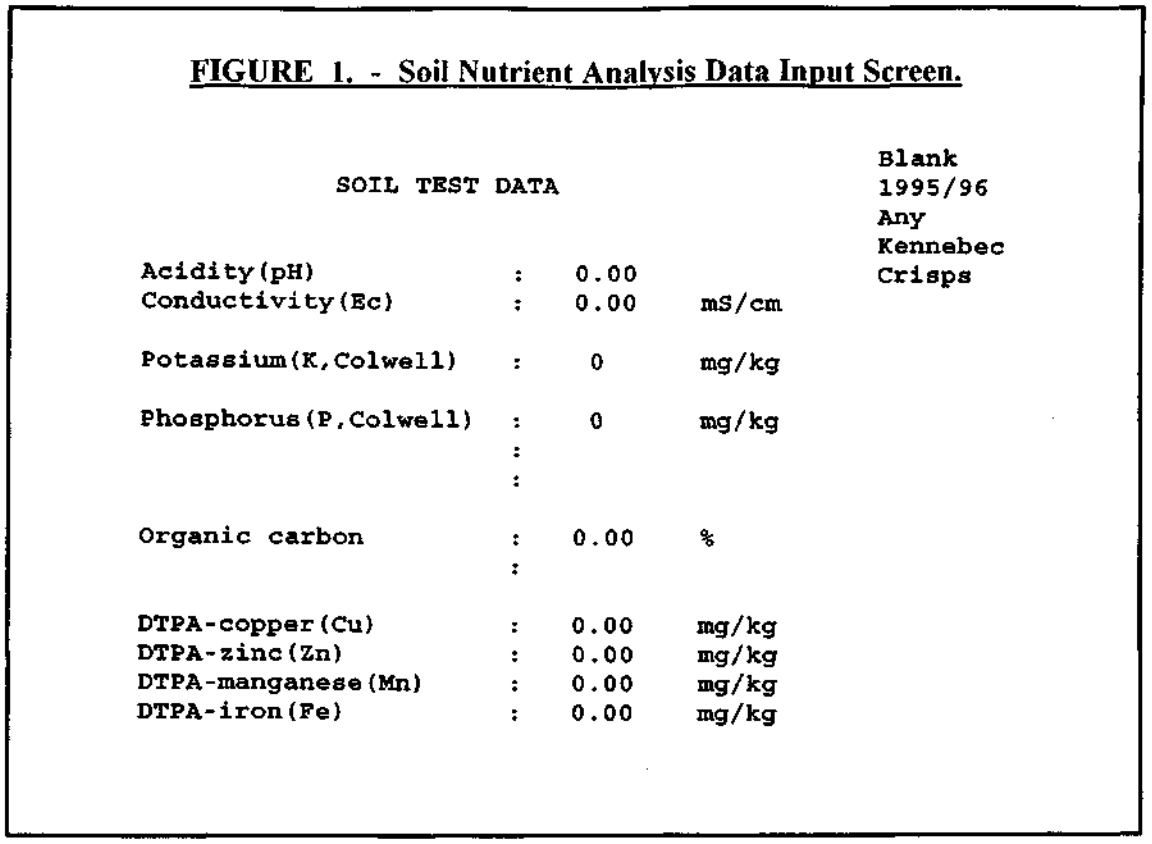


FIGURE 2. - Horizontal Bargraph Display for Soil Analysis Data

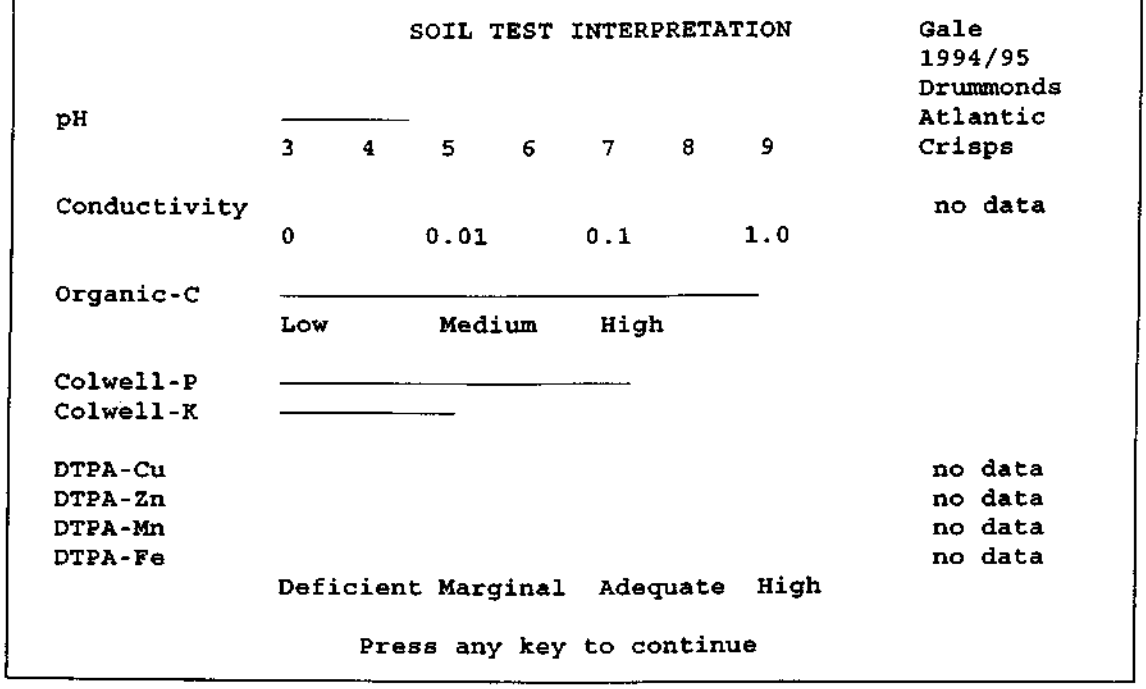


FIGURE 3. - Nitrogen Fertiliser Recommendation Display.

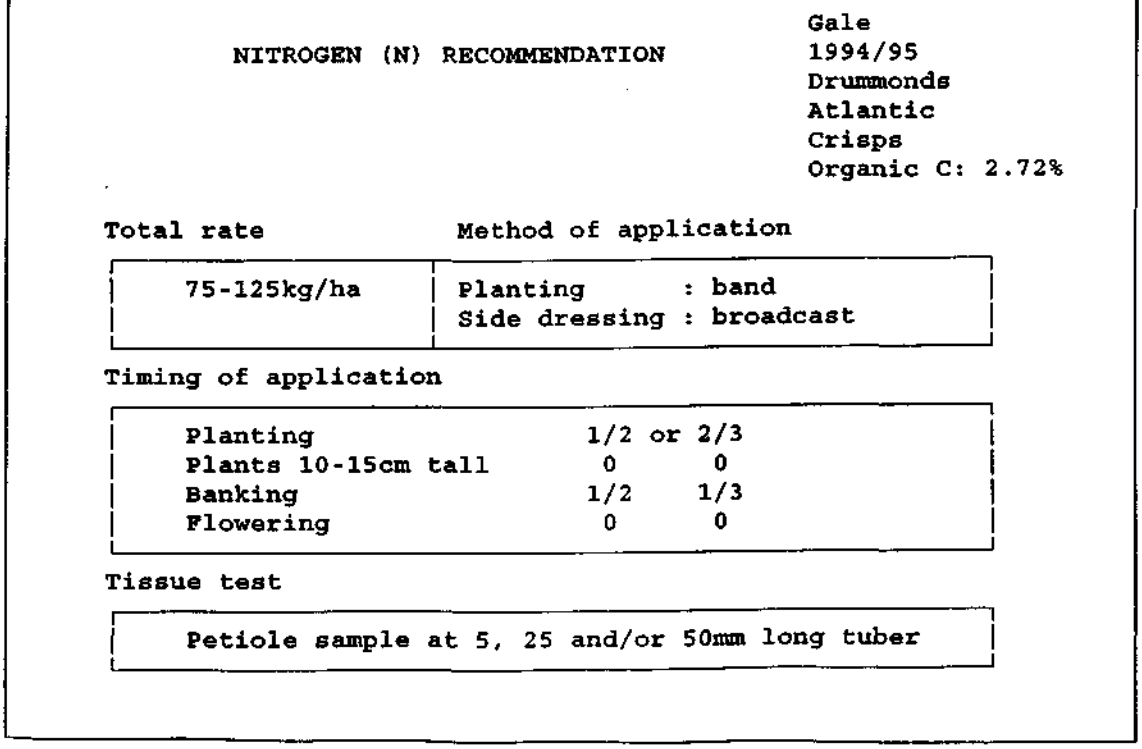


FIGURE 4. - Phosphorus Fertiliser Recommendation Display.

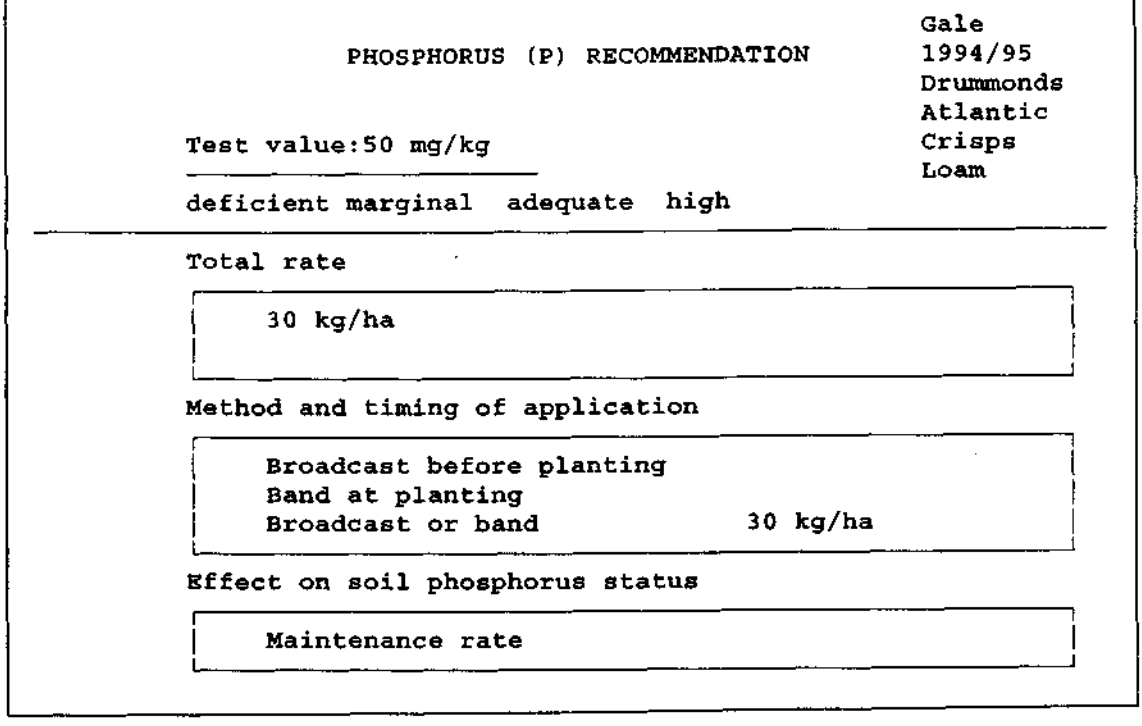
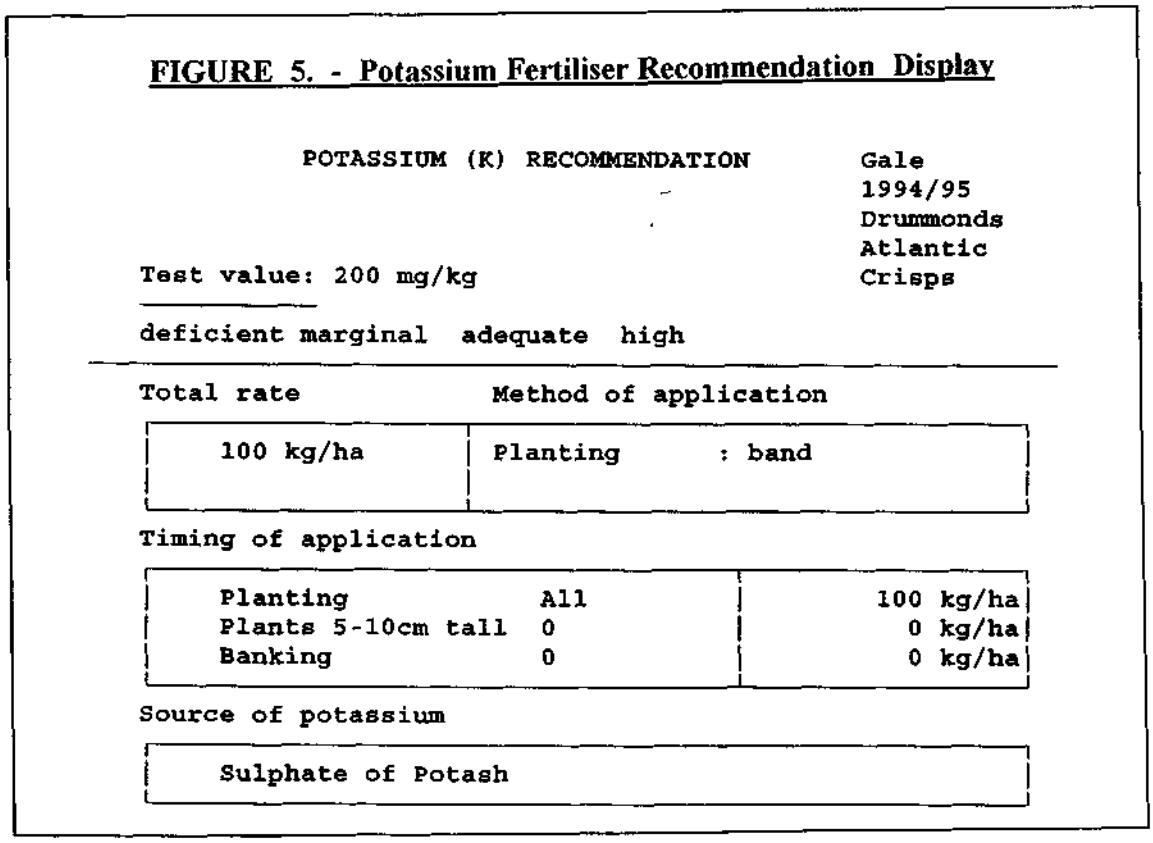


FIGURE 5. - Potassium Fertiliser Recommendation Display



Tissue Analysis and Interpretation.

The tissue analysis and interpretation module of the program was developed in 2 phases, initially with the output as a simple horizontal bar graph relating the analysis values to deficient, adequate and high interpretation ranges. This was later modified to be presented in a scatter plot which related the analysis value to the crop growth stage and the acceptable nutrient ranges. The main advantage of this type of presentation was the ability to plot the trend in nutrient values for a particular crop and/or make easy comparisons with the values being obtained for other crops.

Tissue data for the full range of plant nutrients (Table 3.) is input to the system on a single data entry screen. With the current software, up to 3 tissue sampling times can be input for all nutrients (except sap-nitrate) for one crop. Up to 10 sap-nitrate readings can be input for a single crop.

The range of output options available in the software for plant tissue interpretation are listed in Table 4 together with the Figure references for an example of that output display.

TABLE 3. Plant Tissue Testing Data

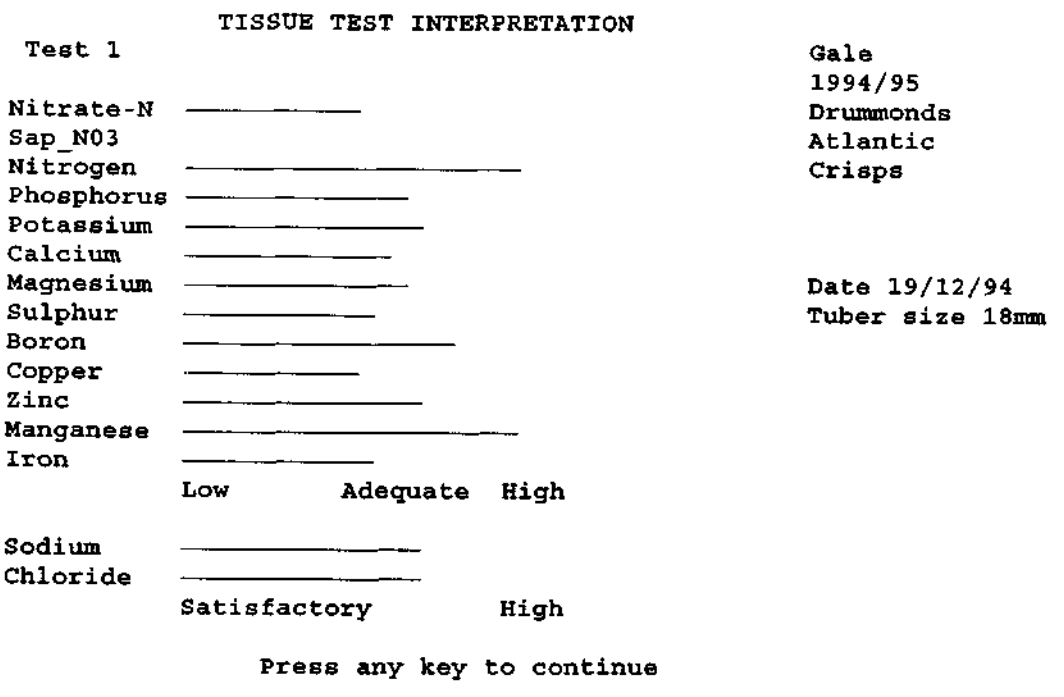
♦ Sample Date		
♦ Tuber Size		(mm)
♦ Nitrate - N		(%)
♦ Sap - NO3		(mg/kg)
♦ Nitrogen	N	(%)
♦ Phosphorus	P	(%)
♦ Potassium	K	(%)
♦ Calcium	Ca	(%)
♦ Magnesium	Mg	(%)
♦ Sodium	Na	(%)
♦ Chloride	Cl	(%)
♦ Sulphur	S	(%)
♦ Boron	B	(mg/kg)
♦ Copper	Cu	(mg/kg)
♦ Zinc	Zn	(mg/kg)
♦ Manganese	Mn	(mg/kg)
♦ Iron	Fe	(mg/kg)
♦ Aluminium	Al	(mg/kg)

TABLE 4. Tissue Interpretation Output Options and Display Example Figures

OUTPUT OPTIONS	FIGURE No.
Horizontal Bar Graph, All Nutrients	6
Horizontal Bar Graph, Sampling Time Comp	7
Scatter Plot, Single Crop	8
Scatter Plot, Multiple Crops	9
Scatter Plot, Multiple Nutrients (Print only)	10

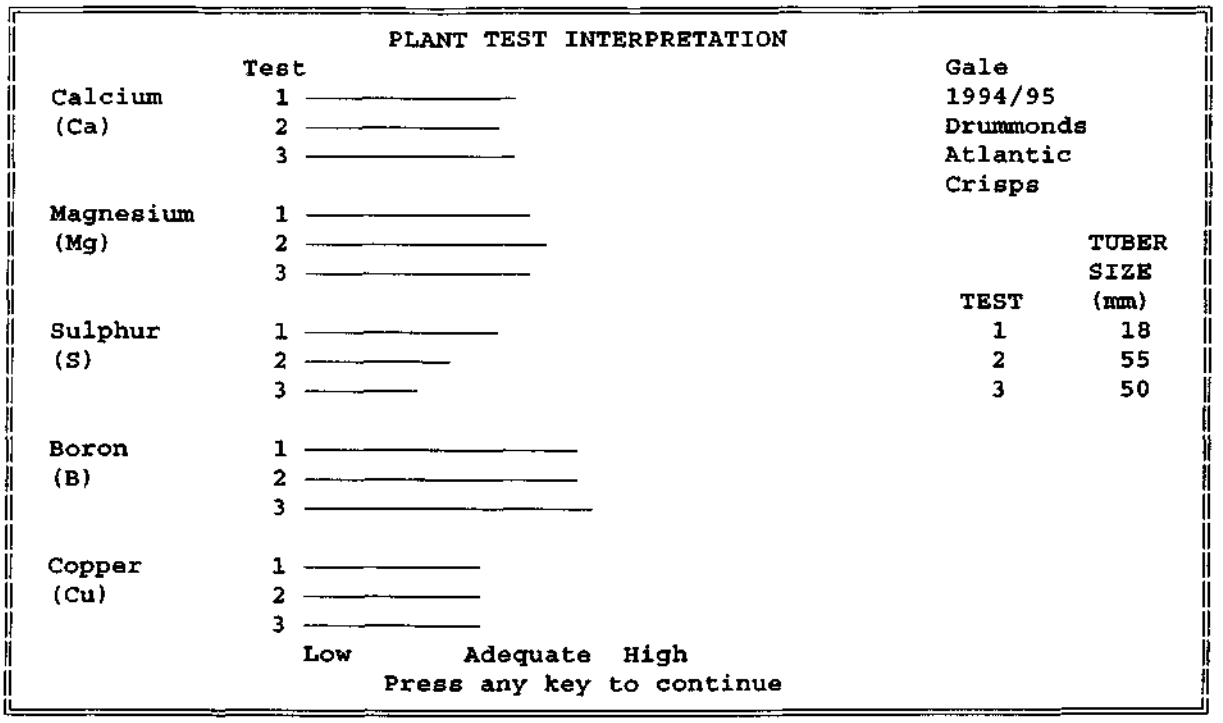
No recommendations regarding possible remedial actions for specific nutrient toxicity or deficiency are made within the program.

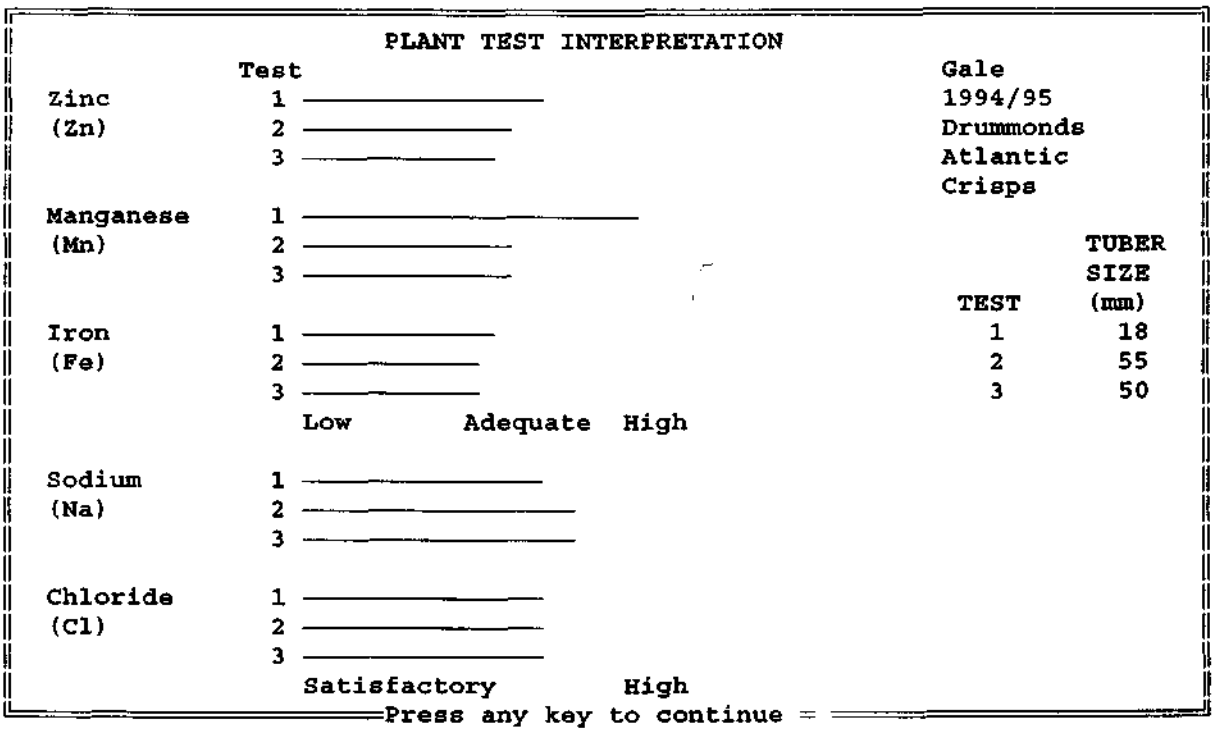
FIGURE 6. - Horizontal Bar Graph Type Display for All Plant Nutrients



NOTE: On the computer screen, colored bands are displayed to represent the Low, Adequate and High or Satisfactory and High Ranges.

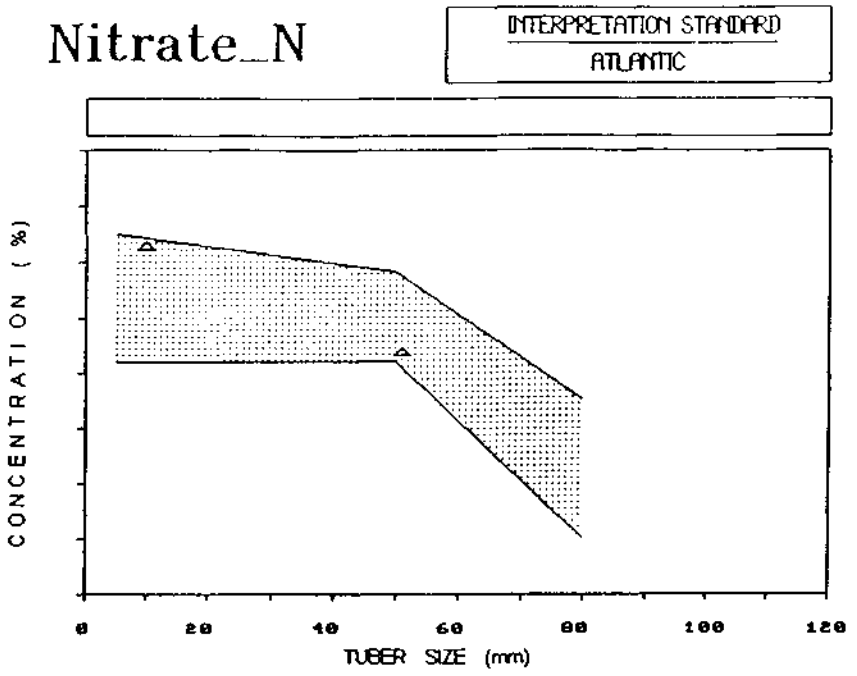
FIGURE 7. - Horizontal Bar Graph Display of Plant Nutrients at Three Sampling Times. (2 Screens)





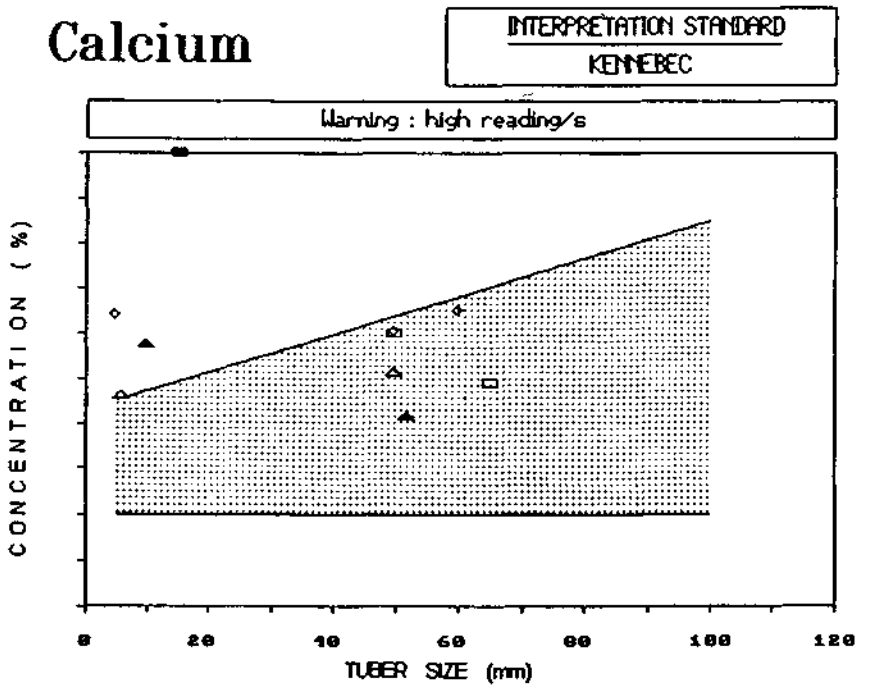
NOTE: On the computer screen, colored bands are displayed to represent the Low, Adequate and High or Satisfactory and High Ranges.

FIGURE 8. - Scatter Plot Display of Plant Nutrient Trend for a Single Crop.



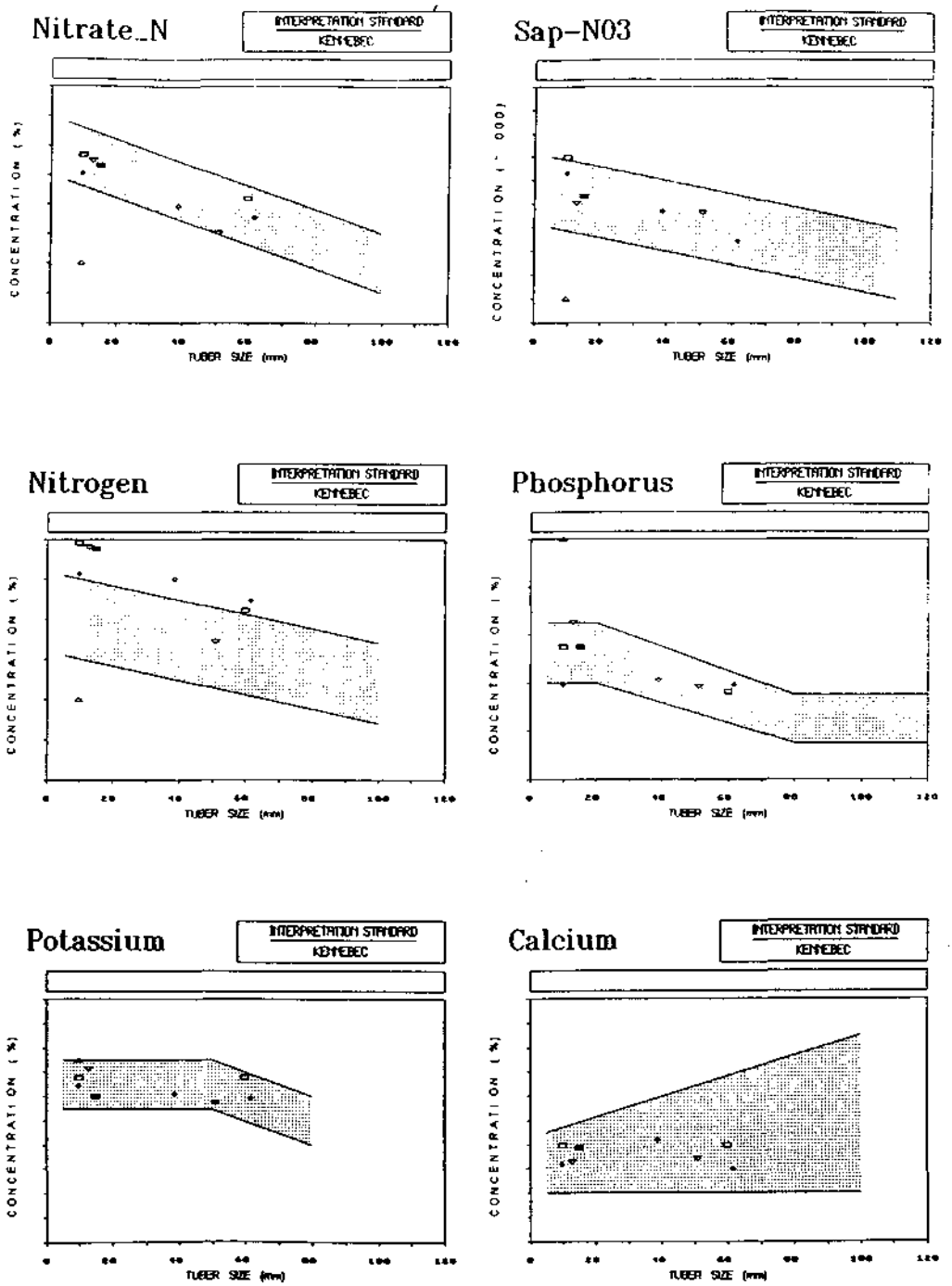
NOTE: On the computer screen a colored band is displayed to represent the Adequate Range.

FIGURE 9. - Scatter Plot Display of Plant Tissue Data for Multiple Crops (max. 10 crops)



NOTE: On the computer screen a colored band is displayed to represent the Adequate Range.

FIGURE 10. - Example of Printout for Multiple Nutrients and Maximum of 10 Crops per Nutrient (Hardcopy Only)



Data and Record Management.

The software has components to properly manage a large number of the crop records on the one working file. The main menu (Table 5.) provides routine procedures for the backup of data files, the deleting of records and archiving of records from the working file. The later option allows the data records for a particular crop to be removed from the active data file and added to a separate file, which can be retrieved if necessary for reviewing at a later date. This archival procedure is for individual crop records which means the working file can be maintained with only the records for crops which are still of immediate interest to the user.

TABLE 5. Main Menu Selections

Create New Record
Select Existing Record
Edit
Make Decisions
Print Report
Archive/Delete Records
Backup Data
Help Menu
Quit

In the program various options are available to the user to make the selection of a crop or crops to work with as easy as possible. Users can page through the entire crop file until the required crop is located or use a selection process to select out a particular group of records on which the final selection can be made. Selection for the grouping of the records can be made on the basis of grower, paddock, region or variety. This selection process not only saves time in paging through a large number of crop records when searching for a particular crop but is used in the plant tissue graphical interpretation part of the program for easy selection of a common group of crops for plotting on the one graph.

There are extensive cross checks and confirmation procedures in the program to ensure that the user is working with the correct crop information, particularly when appending additional data or editing crop information data. Most input and output screens have the basic crop record data (grower, paddock, year, variety, end use) displayed in a window on the screen as a reminder of the crop being dealt with at the time. (see Figures 2 -7.)

Additional Crop Management Data

There is allowance in the program to record for each crop additional crop management information like application dates for fertiliser sidedressings, spray applications, for pest and disease control, banking date and irrigation and rainfall. Yield and quality information for the crop can also be entered to the data file for later reference. These aspects of the program are not well developed as they were considered to be of lower priority but are included so a record of some other key crop factors for that crop are stored in the one location. This information could be valuable at some future date when that paddock under rotation is again planted to potatoes.

Crop Monitoring.

During the first year of the project the plant nutrient status of a wide range of crops from different regions was monitored. The information gained from this work was used to help confirm the plant nutrient standards used in this module of the software. It was important to check the validity of the interpretation standards across all the major production regions of South Australia. The crop monitoring work was also used to help define more closely the varietal variations and necessary changes to the standards for the main varieties grown in South Australia.

Software Programming

The source code for the decision support software is from dBase IV and Clipper (Ver. 5.2) with the later being used to compile a stand alone program for the full software package. The graphics are developed from the dGE (Ver. 2) software library which is compiled by Clipper as part of the package.

All the information for the interpretation of the soil and plant test data is stored in database files which allows for easy modification of critical values and the extension of the system to include additional varieties, regions, soil types etc. All the crop information is also stored in a number of relational database files.

Software Testing.

This decision support software was developed as a pilot program to assist potato producers in making crop management decisions regarding fertiliser applications and plant health for the production of high yielding crops of quality tubers. The program has been used by staff in SARDI and the former Department of Agriculture since development to provide fertiliser recommendations and check on the plant nutrient status of crops. It has also been used by at least one local consultancy group to monitor crops and advise producers. Through out this period, the interpretation or advice given by the program, has been consistent with the type of recommendations that would be made by experienced R&D staff working on the project.

Future Development Work.

The logical future development for this project is to improve the "user friendliness", modify the program to have a national focus and work to achieve wider use of the program within the potato industry. The plant nutrient analysis has national relevance and could be directly useable after checking of plant analysis data from other states and possibly minor modifications. The soil analysis module is less readily adaptable to national use because of the wide range of soil types existing in the major potato production regions of Australia. The work is continuing under as new 3 year HRDC/industry funded project (PT428) which addresses the future developments above.

Planning for the computer programming work in this new project is well advanced at the present time and a series of experiments to investigate diurnal variation, sampled leaf position and sampling error on plant nutrient composition has been completed. It has been decided with the software development to:

- Develop the software to operate in a windows based environment which will make the program easier to use, present a more "up to date" image, allow for the incorporation of coloured images and resolve a range of hard copy output problems associated with DOS based programs. The development programs most likely to be used will be Microsoft Access and Visual C.
- Two separate packages will be developed, one for the tissue analysis which will have national relevance and the second which will also incorporate the soil analysis module. The later will have particular relevance to South Australia but will be flexible enough, through limited access components, to allow for the modification of the software to suit other growing districts.
- The tissue analysis module will have a symptomatology analysis component added to allow both chemical and symptom analysis of nutrient status.

Concurrently with the software development will be the production of a potato nutrient management manual which will incorporate all aspects of the software and additional reference information.

Acknowledgments

The assistance of the following in this project is gratefully acknowledged:

- Horticultural Research and Development Corporation and the potato industry for financial support.
- Potato growers in South Australia for the use of their potato crops in crop monitoring and leaf sampling.
- Mr Edward Trojanowski for software programming.