INTERMOUNTAIN FOREST TREE NUTRITION COOPERATIVE (IFTNC)

FOREST FOLIAR NUTRIENT ANALYSIS

VECTOR EXCELL

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OVERVIEW

Vector analysis is a foliar graphical technique used to compare plant growth, nutrient concentrations and nutrient content. It is a useful diagnostic tool to determine nutritional status of trees in response to silvicultural prescriptions such as forest fertilization. Vector analysis has been used over the past few decades to examine plant responses to various treatments. More recently, the IFTNC has used foliar vector analysis to interpret experimental forest nutrient status and tree growth response.

IFTNC staff, graduate students, and associates developed Vector Excell. Vector Excell was written within Microsoft Excel® Visual Basic Editor and runs in a PC (IBM® compatible) environment.

This paper covers Vector Excell installation, data entry and operation. Foliar data collection and foliar vector interpretation is the responsibility of the user and not the IFTNC, although the IFTNC can serve as advisees on these matters. Appendices A, B and C contain foliage collection and vector interpretation materials and vector analysis references, respectively.

INSTALLATION

Vector Excell is a simple software program used as a Microsoft Excel® application. Versions older than Microsoft Excel® 97 may not be capable of running Vector Excell. The Vector Excell program is contained within one file labeled vexcell.xls and is on the 3.5" floppy provided. Vector Excell will run from floppy or hard drive applications, however, Vector Excell will run faster and more efficiently if loaded on the hard drive. Vector Excell does not have installation or load "exe" files but is simply run from the vexcell.xls file as a Microsoft Excel® application.

LANUNCHING VECTOR EXCELL

From your PC click on the Microsoft Excel® spreadsheet package. Once in Microsoft Excel® the user must activate the Analysis ToolPak, which can be done by first selecting the Tools option. Next select the Add-Ins option and finally the ToolPak option. ToolPak settings need only be initiated once per PC. **Vector Excell will not run without the ToolPak option being initiated.** Vector Excell is initiated by bringing the vexcell.xls file into the Microsoft Excel® spreadsheet through the File/Open option. Once the file has been selected Vector Excell will immediately present a Microsoft Excel® Macro menu. Click the "Enable Macros" button to initiate the Vector Excell spreadsheet. Once the "Enable Macros" has been initiated, Vector Excell spreadsheet should appear (Note: you may need to scroll the screen up to view properly). An example of the Vector Excell spreadsheet is shown in Table 1.

FOLIAR ANALYSIS

The basis for interpretation of foliar analysis lies in the relationship between foliar nutrient concentrations and growth. Any effects of nutrient treatments will be shown through nutrient concentrations and foliar dry weights. Foliar concentrations and foliar weights by treatment are the only two variables needed to be entered in Vector Excell. Guidelines for conifer foliar collection, weighing and drying techniques are given in Appendix A. Concentration of the nutrients of interest should be determined by standard laboratory techniques for each treatment.

DATA ENTRY

There are 7 columns in the Vector Excell spreadsheet. Column 4 and column 6 will be used to enter foliar concentrations and dry foliar weights, respectively. Foliar concentrations and sample dry weights are used to calculate nutrient content (column 2). Nutrient content is calculated for each treatment by taking the product of nutrient concentration and foliar unit dry weight. In addition, to allow comparisons between treatments, foliar nutrient concentrations, contents and foliar weights must be normalized relative to the control or reference treatment. These values are represented in columns 3, 5 and 7. Normalization of the data requires that each value for each treatment be divided by the corresponding value for the control or reference treatment and then multiplied by

100. Vector Excell will automatically calculate columns 2, 3, 5 and 7 after foliar concentrations and dry foliage weights are entered in columns 4 and 6. Vector Excell will also generate the appropriate number of treatments by nutrient and place them into column 1. Appendix B contains materials helpful in interpreting foliar vector analysis.

Foliar nutrient concentrations and dry foliar weights by treatment are to be entered in columns 4 and 6. To do this, click the START AND ENTER DATA button located on the top left corner of the Vector Excell spreadsheet. This will prompt Vector Excell at prepare the spreadsheet for data entry. An information box will appear and Vector Excell will ask you to enter the number of treatments. The control or reference treatment is not to be used in determining the number of treatments. For example, if your nutrient regime includes a nitrogen treatment, nitrogen plus potassium treatment and a control, then your entry would be 2. After entering the number of treatments then click on "OK". Vector Excell will generate a table for each nutrient with the appropriate number of treatments, including a control (column 1). An example of this spread sheet is shown in Table 2. Foliar concentrations and sample weight data can simply be entered by typing the data in by hand or using "cut and paste" techniques into columns 4 and 6. It is recommended the data be entered into a spreadsheet for easier access and availability. It is important that the nutrient concentrations and foliar weights be entered in the appropriate rows by treatment. If nutrient data is not available or is missing, Vector Excell will automatically fill those missing values with the number 1. Vector Excell's graphical analysis will not be generated for those missing nutrient values. Table 3 shows a Vector Excell spreadsheet with foliar concentrations and dry sample weights entered.

RELATIVE NUMBER GENERATION

After data entry is completed, click on the PUSH IF DATA HAS BEEN ENTERD button. Vector Excell will now generate relative nutrient contents and concentrations plus relative dry weight values by nutrient and treatment. The resulting spreadsheet should look similar to the spreadsheet in Table 1. Check the data sheet for missing values and possible data entry errors.

GRAPHING

If the data appears accurate and complete, click on the GRAPH button. Vector Excell will then provide a box where titles or graph headings can be typed. Click "OK" after the title has been entered. The graphics routine in Vector Excell will generate graphical representations of the relative nutrient concentrations and content values. Graphs will be generated for all nine nutrients and treatments involved in the analysis, regardless if data was entered for that nutrient. Those nutrients with entered data will appear as normal scatter graphs while nutrients with no data will appear in groups at the origin. Relative sample weights are not represented graphically. Figure 1 shows two vector graphs generated by Vector Excell. The first graph represents a ordinary vector graph generated

from data provided by the user, whereas the second graph represents a graph with missing data. The second graph has no meaning and should be disregarded.

VECTOR AND SAMPLE WEIGHT ENHANCEMENT

Vector Excell does not provide visual vector rays or diagonal weight lines useful in interpreting vector analysis. However, it is a simple task to create these rays and lines by using the drawing option in Microsoft Excel®. If the drawing option is not already present in your tool bar selection, select View and then the Toolbars option. Microsoft Excel® will provide you with a list of tool options from which drawing should be selected. From the drawing tool bar it is simple to create or draw vector lines between vector points through click and drag techniques. In addition, diagonal lines can be created to represent sample weight lines.

VECTOR INTERPRETATION

The vector analysis graphical display may look complicated and confusing, however vector analysis graphing is a simple representation of plotting relative nutrient concentrations against relative nutrient content. Because nutrient content is a function of concentration and weight the data will be correctly positioned among foliar weight diagonal lines. Each point on the vector diagram represents the magnitude and directional shift of each nutrient from the control or reference treatment. Distance from the control represents the responsiveness of the treatment or nutrient being analyzed. It is not the scope of this document to interpret vector analysis, however Appendix B contains helpful vector analysis materials summarized by IFTNC staff. In addition, Appendix C lists several good references on this topic.

SAVING DATA

Graphs and data sheets can be saved at any time after the graphing session has ended by either going to the save option under File or attempting to close Vector Excell. Both avenues for saving will save data and graphs in a file at an address of choice, however, saving by choosing the close option in Vector Excell will cause the program to close after the information is saved, whereas Vector Excell will remain open when using the save option.

CLOSING VECTOR EXCELL

Vector Excell can be closed at any time during the operation by selecting File and Close or clicking on the file X button located in the upper right corner. Microsoft Excell will ask if the vexcell.xls file needs to be saved. This save option should be refused because this may save any changes to the Vector Excell program. Instead select no and you will be exited from Vector Excell.