AN EXCEL BASED WORKBOOK FOR ASSISTING WITH WATER QUALITY INTERPRETATIONS

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ABSTRACT

Clientele using the NMSU Soil, Water, and Agricultural Testing laboratory, as well other commercial labs, are usually given an irrigation water interpretation guideline in the form of a table with acceptable ranges. This approach, while helpful, does not quickly identify areas of concern to the client nor does it assist with estimating leaching fractions when salinity levels are high enough to warrant reclamation. A Microsoft Excel based workbook was developed to assist professionals and clients in quickly identifying irrigation water parameters of concern. Units have also been a source of confusion for some clients. The workbook allows for switching between units to better accommodate user understanding. An optional registration is included at the website to keep users up-to-date with any revisions that may occur as well as allow tracking of general interest in this topic. The workbook is available as NMSU Guide W-102 from the NMSU Cooperative Extension Website http://aces.nmsu.edu/pubs/_water/.

INTRODUCTION

This workbook, available at http://aces.nmsu.edu/pubs/_water/W-102_workbook.xlsx, is designed for Cooperative Extension Agents, NRCS Field Offices, private consultants, and others who work with individuals, who need assistance understanding irrigation water analysis reports. The workbook covers elements of a water quality analysis and assesses limitations associated with an irrigation water source. Leaching fraction is calculated based on additional user inputs as well as nutrient loading on a per acre inch basis. Clients must have Microsoft Excel 2007, or later, installed on their computer; security preferences must be set in Microsoft Excel to allow macros with this workbook.

METHODS

Inputs

Users can enter irrigation water test report results directly into the “Report” tab of the workbook. The following analyses are considered useful in determining irrigation water quality for agriculture: pH, electrical conductivity (EC), calcium (Ca), magnesium (Mg), sodium (Na), chloride (Cl), boron (B), sulfate (SO4), and bicarbonate (HCO3). Users can select the units the lab uses to report the values (mEq/l or mg/l). Cells highlighted in orange are for user inputs.

Directions

Cells B7 to B11 and D11 are used for client information and sample identification. Data from the laboratory report are entered in cells C14 (pH), C16 (EC), C17 (total dissolved solids, TDS), C22 (Ca), C23 (Mg), C24 (Na), C32 (Cl), C34 (B), C35 (HCO_3), C38 (SO_4), C39 (nitrate, NO_3), and C40 (potassium, K). Units can be toggled just to the right of each cell in column D. If there are no data for a particular test, that cell should be left blank and “No Data” should appear to the right of the blank cell.

Sections

Salinity. Laboratories may report either TDS or EC. A useful conversion factor was provided by Rhoades et al. (1992): For water with an EC between 0.1 and 5.0 mmhos/cm, multiply EC by 640 to estimate TDS in mg/l. For water EC greater than 5.0 mmhos/cm, multiply EC by 800 to estimate TDS. This calculation is performed in the report sheet in cells C18 and C19 (mmhos/cm = dS/m, mg/l = ppm). The EC for water is also often abbreviated ECw.

Infiltration Concerns. Calcium, magnesium, and sodium are used to calculate the sodium adsorption ratio (SAR) of the irrigation water (cell C26). The adjusted SAR (cell C27) is calculated using information from Suarez (1981), which includes the bicarbonate content of the irrigation water. The permeability hazard of an irrigation water sample is related to both the SAR and EC of the irrigation water. Cells Q21 to BQ68 on the "Report" tab are a lookup table based on Suarez (1981) that estimates the permeability hazard based on SAR, or adjusted SAR, and EC. The adjusted SAR relies on a calcium precipitation factor referred to as Cax. Cax is estimated from a lookup table, but can also be estimated from the "Cax Graph" tab: Move the vertical red line to the x-axis value shown in cell C39. Then move the horizontal red line to intersect the ECw value nearest the reported ECw along the vertical red line. Enter the Cax value found along the Y-axis into cell D42.

Specific Ion Effects. Bicarbonate, boron, chloride, and sodium are four ions that can have negative effects on plant growth. Please refer to Rhoades et al. (1991) or Horneck et al. (2007) for descriptions of these ion effects.

Nutrient Status. Sulfate, nitrate, and potassium are often an option for water quality test reports. Accounting for these nutrients in nutrient management plans is necessary and can save money in fertilizer input expenses. The workbook calculates the pounds of nutrient added to an acre of soil that receives an inch of water (cells E38 to E41).

Suggested Leaching Fraction for Selected Crop or Soil EC and Irrigation Frequency. This section allows the user to select a combination of crop and location from a pull-down menu in cell B46. Each crop/location combination is tied to values for estimated consumptive use and soil saturated paste EC (abbreviated ECe) at which there is a 10% yield reduction. The table can be found on the "Crop Table" tab and is also provided by New Mexico NRCS salinity workbook AGRO-61 "Irrigated Leaching Index and Salt Management Tool for New Mexico" (Sporcic and Sheffe, 2001), available at http://www.nm.nrcs.usda.gov/technical/tech-notes/agro.html.

Leaching Fraction & Crop Sensitivity to Salinity (Cell C46). Users must find the EC 10% value for their selected crop/location from the "Crop Table" tab and enter that number in cell C46 on the "Report" tab. The user may also enter, in cell C46, the desired or current soil test EC from a saturated paste extract. Irrigation frequency will have an effect on your current irrigation water management practices. The leaching fraction for a high frequency or low frequency irrigation system is calculated in cells D46 and E46, respectively. High frequency systems include drip and sprinkler systems that are run frequently to deliver water to a crop. A low frequency system is one that delivers water infrequently through gated pipe, border/dike, or flooding methods. Leaching fractions will be greater for low frequency systems. Estimated consumptive use and leaching fraction are calculated for both the low and high frequency systems. The quantity given in cells D48 and E48 does not take irrigation system efficiency into account. Consumptive use varies by location. Leaching fraction is calculated from the following formulas:

Low Frequency: 0.3086/(ECe/ECw)^1.702

High Frequency: 0.1794/(ECe/ECw)^3.0417

Plugging Potential. Total suspended solids, bacterial content, hydrogen sulfide, iron, manganese, and bicarbonate all contribute to potential plugging of small openings in drip irrigation systems. These openings can be the emitters or the screens through which water is filtered. Please refer to Bucks et al. (1979) and Encisco et al. (2004) for more information.

CONCLUSIONS

Preliminary observations suggest that the workbook is helpful to clients needing a visual aid in understanding irrigation water analyses and a preliminary idea of what management practices may be needed to compensate for poor water quality.

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