SOIL 4234 Laboratory Exercise 1

Nutrient Mobility and Fertilizer Leaching

Overview:

The degree to which fertilizer materials leach, or wash through the soil, is a concern both from the viewpoint of general society and interests in protecting the environment, and the agricultural community and sustainable food and fiber production. When fertilizers leach through the soil they may reach groundwater aquifers and degrade the quality of public drinking water sources. If the nutrients in the drinking water are a health hazard and the level exceeds established standards (e.g. nitrate-N in excess of 10 ppm), then society may wish to limit fertilizer use, or at least have input to how the fertilizer is managed. The agricultural community is interested in knowing if fertilizers leach because this could decrease the effectiveness in relation to plant growth and crop production. If the fertilizer leaches easily, more fertilizer may need to be applied to meet the needs of the crop.

Bray's nutrient 'Mobility Concept' indicates that management of nutrient inputs to correct deficiencies, or project deficiencies, is closely linked to whether the nutrient is mobile in the soil or not. Fertilizers that are subject to leaching must contain nutrient forms that are relatively mobile in the soil.

Approach:

Nutrient Mobility. High rates of N, P, and K fertilizers are applied in the field to the surface of a relatively level, permeable soil in advance of a normal rainy period or irrigation. High rates are used to assure nutrient accumulation levels can be detected by common nutrient extraction methods and that the levels will be much higher than that found in unfertilized (control) soil.

Amounts of each nutrient extracted from fertilized areas are first adjusted by subtracting the amounts found in similar soil layers of the control soil. A second adjustment may be made for soil-changes to the nutrient that causes it to be "non-extractable". The amount found in each layer of soil extracted is summed and the sum divided into the total added to obtain an "adjustment" factor for that nutrient. This factor is used to adjust the amount of that nutrient found in each layer before comparisons among nutrients are made. Step-wise calculations are made by completing indicated tables.

Fertilizer Leaching. Fertilizer leaching is estimated by calculating changes in the water-soluble forms of the nutrients found in subsoil of fertilized areas.

Objectives:

1. Estimate the relative mobility in soil of nitrogen (NH_4^+ and NO_3^-), phosphorus ($H_2PO_4^-$, and HPO_4^{2-}), and potassium (K^+),when applied to the soil surface of a cultivated field.
2. Estimate the percentage of fertilizer added that has leached into the subsoil.

Materials and Methods:

1. The fertilizer materials are Urea {$((NH_2)_2CO)$ 46-0-0}, monocalcium phosphate ($Ca(H_2PO_4)_2$, 0-46-0) and potassium chloride (KCl, 0-0-60).
2. Fertilizers are applied as solution form to the surface of "plots" at the rate of 1000 lb/acre of N, P_2O_5, and K_2O.
    a. Plots will be defined by the dimensions of a soil probe tube filled with soil up to a level of 18".
    b. Lab 1 will use the fine textured soil while Lab 2 will use the course textured soil.
    c. Fertilizer materials will be applied in a volume of solution equivalent to 2 inch of irrigation.
    d. After one week an additional 9 inches of water will be applied to each treatment.

3. Two weeks after the initial fertilizer application 0-6", 6"-12, and 12-18"soil samples will be obtained from each fertilized and control plot.
4. Soils will be analyzed for plant-available and water soluble forms of the nutrients.
5. Estimated relative soil-mobility of N, P, and K, will be calculated by performing the indicated calculations, from fertilizer application and soil test values, to complete the following tables.

Treatments	
1	Check
2	Nitrogen
3	Phosphorus
4	Potassium
5	N + stabilizer

Results:

Nutrient Mobility Nine inches of water added to leach the fertilizer materials. Soil test results from field samples have been entered in Table 1. Perform the indicated calculations to complete Table 1.

Table 1. Soil test results[1] of surface (0-6") and subsoil (6-18") layers of sampled soil.

	NH_4-N	NO_3-N	P	K	N+
Layer	Fertilized				
Surface					
Sub					
	Control				
Surface					
Sub					
	Fertilized – Control[2]				
Surface					
Sub					
Sum found					
Total added	**500**	**500**	**1000**	**1000**	
	Percentage of total applied found[3]				
Surface					
Sub					
Calculated Immobility and Mobility					
Immobility[4] (X)	( )	( )	( )	( )	
Mobility[5]					
Average mobility[6]					
Relative mobility[7]					

[1]All values in units of lb/acre unless otherwise indicated.
[2]For each nutrient form and layer, subtract the control value from the fertilized value.
[3]Divide 'Fertilized-Control values' by 'total added' and multiply by 100.
[4]Calculated immobility is based on nutrient retention in the surface soil. Dividing each value for 'surface, percentage of total applied found' by the largest value in that row and multiply by 100. Percent mobility may be assumed to be the difference between 100 and percentage immobility, therefore, subtract the percentage immobility from 100 and recording the value in **( )**.
[5] Calculate mobility by dividing each value for 'Sub, percentage of total applied found' by the largest value in that row and multiplying by 100.

[6]Sum the value for mobility calculated from surface soil retention **( )** and that found in the subsoil and divide the result by two.
[7]Divide the largest value into each value, multiply by 10 and round the value to a whole number.

Fertilizer Leaching. Record soil test results, as provided by the instructor, and perform the indicated calculations to complete Table 2.

Table 2. Plant-available[1] nutrient levels from soil test results of **subsoil** (6-18 inch) from fertilized and control soil.

		N	P	K	N+
Area	Nutrient				
Fertilized					
Control					
Fertilized – Control[2]					
Total added		**1000**	**1000**	**1000**	
Percent leached[3]					

[1]All values in units of lb/acre unless otherwise indicated. P and K extracted by Mehlich-3, Cl by saturated $CaSO_4$ solution, and N using 1M $CaCl_2$.
[2]For each nutrient form, subtract the value for the control from the value for the fertilized area.
[3]Divide 'fertilized – control' by 'total added' and multiply by 100.

Questions:

1. The most mobile nutrient was _____.
2. The second most mobile nutrient was _____.
3. Identify a chemical characteristic of the two most mobile nutrients that might account for their high mobility and explain why this characteristic is related to high mobility of nutrients in soils.

4. The least mobile nutrient in this soil was _____.
5. The second least mobile nutrient was _____.
6. Identify chemical characteristic(s) of the two least mobile nutrients that might account for their low mobility and explain the relationship to low mobility of nutrients in soils.

7. Compare relative nutrient mobility values and percentage of fertilizer leached. Do these results agree?
   If not, explain the differences.

8. Explain why you believe fertilizer leaching is or is not a serious problem in Oklahoma soils.

9. Describe a condition of this exercise that was not normal for fertilizer use in Oklahoma.

10. What cultural practices (at least two) would you recommend to reduce fertilizer leaching from what was found in this exercise.