Balanced micronutrient management for wheat using GIS techniques

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Abstract
The present paper includes the works done in Golestan province during the year 2005 - 2009 on a research project entitled "Establishing digital spatial pattern map of micronutrients in soils under rain-fed wheat in Golestan Province". The studied areas were under rain-fed wheat cultivation and the total surface area was about 300,000 hectares. Using base maps with a scale of 1:50,000, the area was divided into 3000 grid cells, each of them having one kilometer square area. Using a Global Positioning System (GPS) instrument a composite soil sample was taken from the center of grids and was analyzed for micronutrients namely; Iron, Zinc, Copper, Manganese and Chlorine. After obtaining the laboratory results, for the above stated data set, an electronic layer was created and after performing the interpolation, the layers were vectorized into polygons. Anisotropy of the data sets in different directions was evaluated by the help of variogram surface operation. Then spatial correlation of each data set was calculated. Doing variogram analysis, spatial variation of the data sets was studied and a suitable model was selected finally through point interpolation by the statistical, kriging technique, the digital map of each micronutrient was established.

Key Words
Kriging, spatial correlation, micronutrients, variogram analysis.

Introduction

A GIS (Geographic Information System) is a computer-based technology which manipulates spatial data from various sources. GIS is currently being used in many countries in Asia, to help farmers manage their soil resources more efficiently. The GIS computer system is capable of gathering, storing, and analyzing geographically-referenced information (i.e. information for which the location has been identified). GIS combines different kinds of data, in a way that was never possible before. Information is presented briefly and clearly in the form of a map or diagram making it very easy for people to understand a lot of complicated data. Driven by a large population with growing food demands and very limited available land resources for agricultural use, the critical question was: could current soil fertility management practices used in the intensification of plant production adequately meet those demands in a sustainable way? The fertility maps are useful tools to quantifying land resources. These maps are essential for correct fertilizer recommendations, monitoring changes of soil fertility also to predict toxicity or deficiency of plant nutritent elements in soil.

Material and methods

Based on consultations with the expert specialists working in the different counties of the province, the area under various land uses were determined using 1:50000 geographical map of the province. Areas under rain-fed wheat cultivation were about 300,000 hectares. Using the Ilwis software, and a base map with scale of 1: 50,000, the area was divided into 3000 grid cells with the size of 1x1 km. Using Global Positioning System (GPS) a composite soil sample was collected from any particular cell and being analyzed for parameters namely; Fe, Zn, Mn, Cl and Cu. At the time of sampling some additional information like latitude, longitude, elevation, owner's name, date of sampling, kind of water resources, possibility of water logging, present and previous crop, among other variables were collected and recorded. Samples were analyzed in the laboratory of the Department of Soil and Water Research in Golestan province. Electronic layers were created and after interpolation the layers were polygonized. After doing geostatistical analysis on the results for particular in micronutrients, using ArcGIS 9.0 software a distribution map has been drawn. Then the anisotropy of the data sets was evaluated by variogram surface operation and then the spatial correlation of each data set was calculated. Doing variogram analysis, spatial variation of the data sets was studied and a suitable model was selected. Finally through point interpolation by the statistical, kriging technique, the digital map of each micronutrient established and statistical parameters; mean, maximum and minimum recorded concentrations and their standard deviations were calculated.

Results

Some statistical parameters namely; mean, maximum and minimum recorded concentration and standard deviation which are derived for each micronutrient data are presented in Table 1.

Table 1. Some statistical results for micronutrients in soil extractss in Golestan Province.

Element	Number of points	Mean	Maximum concentration	Minimum concentration	Standard Deviation
Zn (meq/L)	2870	0.77	10	0.2	0.65
Fe (meq/L)	2870	12.3	40	0.4	15.77
Mn (meq/L)	2870	3.53	92	0.2	3.52
Cu (meq/L)	2870	2.39	31	0.3	1.55
Cl (meq/L)	2870	8.1	310	0.4	2.5

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