Mapping the Nutrients Distribution to Reduce Cultivation Practices and Land Degradation Using Geospatial Information System (GIS)

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Abstract
Soil management to sustain it, is one the most important options to promote agroecosystems sustainable productivity. Unfortunately, lack of information on the distribution patterns of soil nutrients is one of the main problems which face the lands to degradation. Annually, intensive cultivation activities are done to incorporate nutrients with soil, especially in high-input crops such as wheat and soybean, while many parts of lands don't need to add fertilizers especially in the time of seedbed preparation stage. Precision management of nutrients needs informative maps which show the distribution pattern of fertilizers. In this study, a field divided to different parcels with 51 points throughout the field. These points were sampled to determine pH, Ca, and Mg content. The data were used to interpolate aforementioned nutrients contents in the study field. Digital elevation model (DEM) was provided from 1/25000 maps and Spline method was used to interpolate nutrient contents. Our results showed that different zones are detectable in respect to reclassified nutrient layers. This showed that in these zones the nutrients deficiency could be calculated to provide them in sufficient levels for different crops. This can help us to reduce the frequency of cultivation practices to incorporate fertilizers witch disposes the land to degradation. The level of nutrients showed that we can neglect pre-sowing cultivation practices to incorporate fertilizers. In this study, all measured nutrient were classified in raster format to calculate fertilizers recommendations.
Keywords: Land degradation, Cultivation, Fertilizers, GIS.

Introduction
Soil degradation implies long-term decline in soils productivity and its environment moderating capacity (Lal, 1994a; 1997). In other words, it means decline in soil quality, or reduction in relation to specific functions of value to humans. Agricultural input management and necessity for elimination of possible mistakes that resulting from no evenness in experimental units in agricultural researches on the other hands, need to have quantitative and comprehensive information from nutrients distribution and effective physical characters to crop production that in addition to assess deficiency or toxicity nutrient, plan to need or non need to fertilizer and type of carrying out a project based on nutrition studies. Soil management to sustain it, is one the most important options to promote agroecosystems sustainable productivity. Unfortunately, lack of information on the distribution patterns of soil nutrients is one of the main problems which face the lands to degradation. Annually, intensive cultivation activities are done to incorporate nutrients with soil, especially in high-input crops such as wheat and soybean, while many parts of lands don't need to add fertilizers especially in the time of seedbed preparation stage. Precision management of nutrients needs informative maps which show the distribution pattern of fertilizers. Grid soil sampling and variable rate fertilizer applications are a part of the precision agriculture movement that has captured the interest of many farmers. Although many believe that choosing the best gridding and interpolation method is important, research has shown this is not the case. If each soil sample represents each sampling area appropriately and there are enough points over a field, the interpolation method used is not a major issue.
In present, new technologies such as Geographic Information system and classical and geostatistical interpolation methods are instruments that in addition to produce high resolution maps, determine changes range and sensitive classes and prevent from ultra-use inputs. It is necessary to determine the field document as physical and chemical characterestrization. Thus to assess fertilizer needs it is necessary to provide accurate and classificated maps by difference between nutrient sufficient amounts. This research was carried out to determine pH value, Ca, and Mg content in a raster layer to assess precise deficiency values. different zones the nutrients deficiency could be calculated to provide them in sufficient levels for different crops. This can

help us to reduce the frequency of cultivation practices to incorporate fertilizers witch disposes the land to degradation.

Material and methods

this study was carried out in Research farm of Gorgan University of Agricultural Science and Natural Resources, Iran, is located in 54.32 ^{0}E and 36.83 ^{0}L, by 85102 m^2 area. For this purpose the field was divided to different parcels with 51 points by 25m × 100m distance grid cells throughout the felid. The samples taken from 30 cm soil depth in the transection to determine pH, Ca, and Mg content. Field border was determined by GPS, the data were used to interpolate aforementioned nutrients contents in the study field. Digital elevation model (DEM) was provided from 1/25000 maps and "topo to raster" function with the baselines of contours which were queried from aforementioned maps and Spline(sp) and Inverse Distance Weight(ID) method was used to interpolate nutrient contents. Nutrient threshold is used to classified zones in appropriate and inappropriate areas. Ca and Mg were measured by saturation extraction of soil and flame photometer instrument and pH was determined by saturation extraction of soil using a pH meter. Field grids and sampling points are presented in Fig.1.

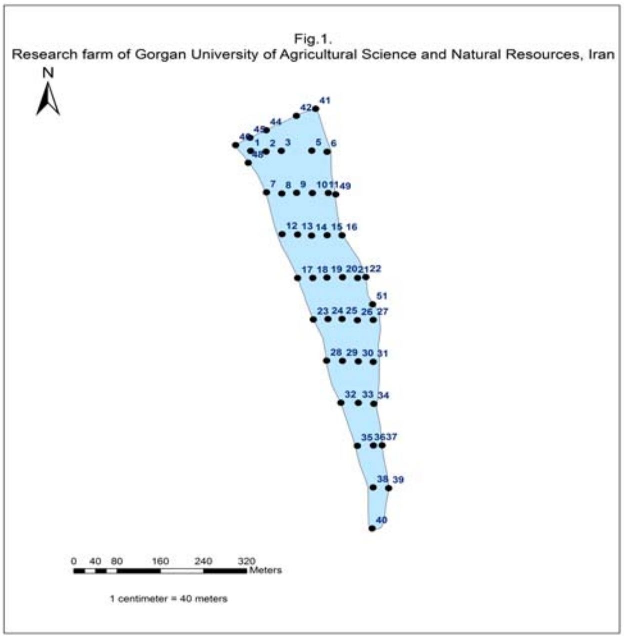

Fig.1. Field border and sampling points based on.

Results

In this study, ID and SP as two interpolation methods were used to evaluate pH, Ca and Mg. the results indicated that both of them are appropriate methods, this was considered by comparing observed against interpolated data. For SP and ID methods, respectively, soil Ca content varied from 0.55 to 43 meq.L^{-1} and 0 to 41.20 meq.L^{-1} (Fig.2.).

To reclassify these maps and determine favorable and unfavorable areas plant response threshold to Ca was considered Ca content range for plants is changed from 2 to 27 meq.L^{-1}. Favorable and unfavorable zones are indicated in Fig. 3. Our result indicated that favorable and unfavorable zones areas were as 84461 and 652 m^2, respectively.

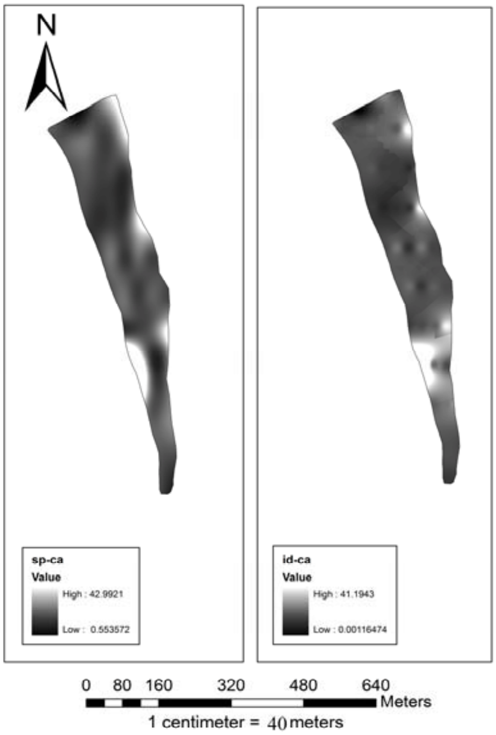

Fig. 2. Ca variability (meq.L^{-1}) in studied field based on two interpolated methods

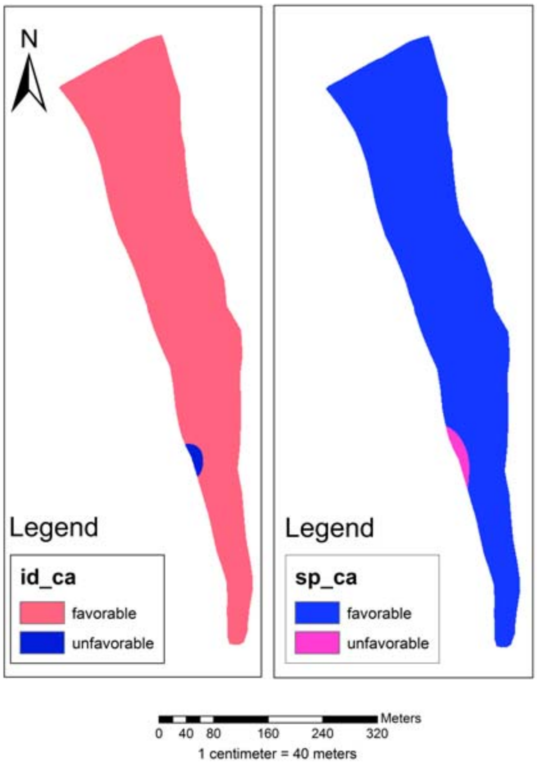

Fig. 3. Favorable and unfavorable area for soil Ca content base on ID and SP interpolation methods in studied area.

These methods that were used for Ca were used for Mg and pH, too. The results showed that are presented in Figs. 4 and 5. According to results and Mg map it is understood that all area of this field are favorable regarding to Mg soil content.

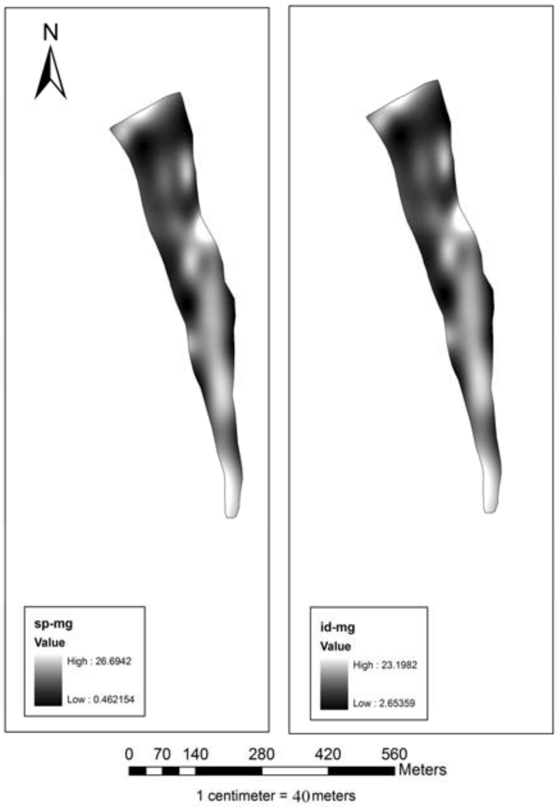

Fig. 4. Mg variability (meq.L^{-1}) in studied area by ID and SP interpolation methods .

Field pH changed between 7.86-7.96 and 7.88-7.96 base on SP and ID methods, respectively. It can be resulted that there are no difference between these two interpolation methods to interpolate pH. All areas of field have slightly alkaline soil.

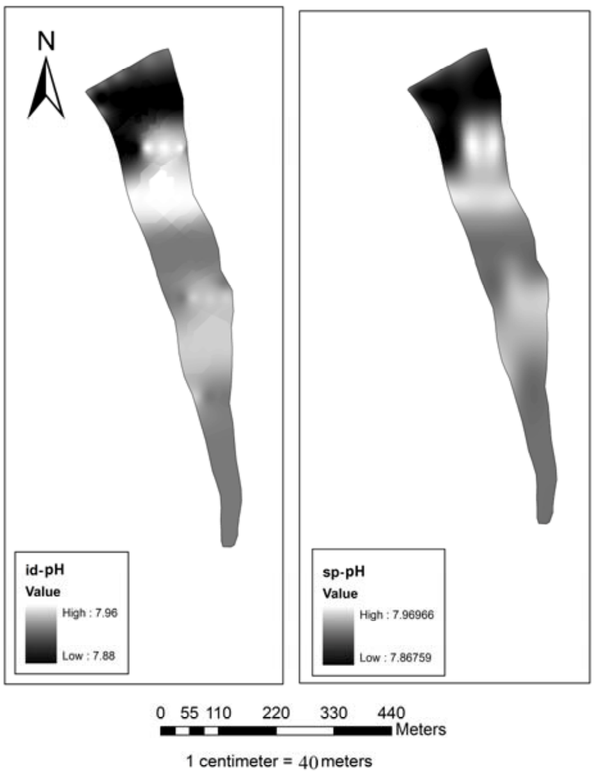

Fig. 5. pH range in studied field base on ID and SP interpolation methods.

Discussion

Many farmers because of continued advances in soil management and crop production technology that have maintained or increased yields in spite of soil erosion, others have not been aware of the increasing problem on farmlands. There is a lack of prioritized and strategic problem-solving agricultural research that is related to plant nutrition management and the incorporation of mineral and organic sources of plant nutrients into the soil. Determining of proper amount of fertilizer for increase in yield is economically reasonable for farmers. It is also desirable from the view point of ecology since excessive use of chemicals cause soil pollution.

Variable rate fertilization requires extra expense and effort plus the use of often unfamiliar technology. To quantify the distribution of spatial patterns and changes in soil nutrients, geostatistics has been applied (e.g., Van Meirvenne et al., 1996; Saldan ˜a et al., 1998; Chevallier et al., 2000; Frogbrook and Oliver, 2001). Geostatistics provides tools to describe and predict spatial variation, and carry out spatial interpolation. A geographic information system (GIS) is useful to produce the interpolated maps for visualization, and for raster GIS maps algebraic functions can calculate and visualize the spatial differences between the maps. Global Positioning Systems (GPS) equipment and computer software are used to outline and grid the field into small manageable units or “cells”. Each grid cell is soil sampled and tested for pH and available nutrients. Fertilizer recommendations are made on each grid cell and the fertilizer is spread by each grid cell using a truck equipped with GPS and variable rate fertilizer spreaders. In order for variable rate fertilization to be profitable, a field must have areas in it with a wide range of soil test levels. A field with only a small amount of soil test variability within it will not justify the expense for the use of variable rate technology (VRT). Fertilizers which have chloride, sulfate and nitrate are the main anion compounds which are used in this field. Continues application of these fertilizers can make unfavorable conditions for soil and its organisms. By these conditions soil degrades gradually. According to these results it is understood that all area of this field are suitable for cropping, approximately. But some part of this field have more calcium that actually this zones excess calcium are sedimented and have not any toxic effects for plants.

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