

Mapping of nutrients status by geographic information system (GIS) in Mantagani village under northern transition zone of Karnataka*

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Abstract: A study was conducted to assess available nutrient status of soils of Mantagani village in north Karnataka by GIS technique. One hundred fifteen samples (0-30 cm) drawn from the farmers' fields were analysed for their fertility status and mapped by geographic information system (GIS) technique. The pH of soil samples was slightly acidic to alkaline. Soil organic matter content was low. Available nitrogen (low; 93% area), phosphorus (low; 24% area, Medium; 76% area) was generally low to medium and available potassium and sulphur were low to high. Regarding available micronutrients, zinc and iron were deficient (88% and 72 % area, respectively) where as, copper and manganese were deficient 54% and 51% area, respectively) to sufficient in these soils.

Keywords: Geographic information system, Global positioning system, Nutrient mapping, Soil fertility status

Introduction

Intensively cultivated soils are being depleted with available nutrients especially secondary and micronutrients. Therefore assessment of fertility status of soils that are being intensively cultivated with high yielding crops needs to be carried out. Soil testing is usually followed by collecting composite soil samples in the fields without geographic reference. The results of such soil testing are not useful for site specific recommendations and subsequent monitoring. Soil available nutrients status of an area using Global Positioning System (GPS) will help in formulating site specific balanced fertilizer recommendation and to understand the status of soil fertility spatially and temporally. Some studies on soil fertility status at representative micro - watershed level have been carried out at University of Agricultural Sciences, Dharwad for a few agro ecological zones. Such information is not available for representative village/ micro watershed of northern transition zone of Karnataka and is essential in planning soil fertility management on watershed/ village basis. The proposed study was planned with the objective of identifying soil fertility constraints.

Material and methods

The selected Mantagani village is located between 14°54' 11.0" and 14°41'58.4" N latitude and 75°25'08.9" and 75°25'01.9" E longitude (Fig.1) with an average elevation of 750 m above Mean Sea Level (MSL). The climate is tropical moist deciduous with maximum temperature of 31.7°C and minimum temperature of 20.1°C. The area receives a mean annual rainfall of 528 mm and having undulating topography with frequent mount like features. Soils on the rolling topography are severally affected by erosion. The area has relief on both west and south directions. It is drained by a Nala in the west and by Varada river in the south.

Soil samples (0-30 cm) at random @ of one sample for 5-6 ha covering cultivated area of the village were collected during May 2008. The number of samples collected in the study area were; 115. The exact sample location was recorded using a GPS. Processed soil samples were analysed for nutrient availability

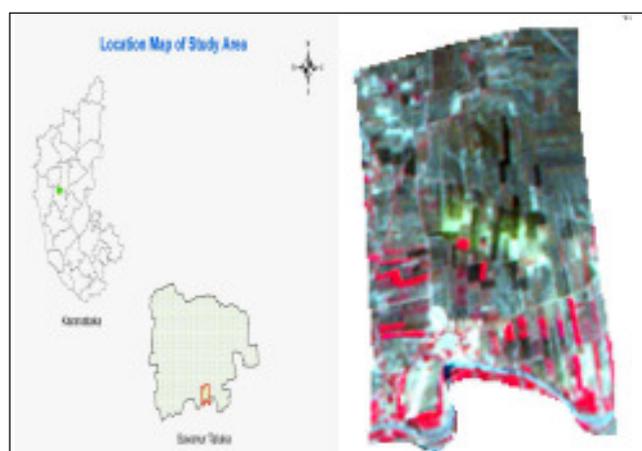


Fig. 1. Location map of the study area

by following standard analytical techniques (Jackson, 1973). Fertility status of N, P, K and S are interpreted as low, medium and high and that of zinc, iron, copper and manganese interpreted as deficient, sufficient and excess by following the criteria (Arora, 2002) given in table 1.

A .dbf file consisting of data for X and Y coordinates in respect of sampling site location was created. A shape file (Vector data) showing the outline of Mantagani village was created. The dbf file was opened in the project window and in X-field, X-coordinates and in Y-field, Y-coordinates were selected. The Z field was used for different nutrients. The Mantagani village shape file was also opened and from the 'surface menu' of spatial analyst, "Interpolate grid option" was selected. On the output "grid specification dialogue", output grid extend chosen was same as Mantagani village shape and the interpolation method employed was spline. Then map was reclassified based on ratings of respective nutrients (Table 1).

Results and discussion

The data pertaining to the fertility status of Mantagani village are presented in Tables 2 to 5 and figures 2 to 10. In both black and red soils, the available nitrogen content varied between

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Table 1. Soil fertility ratings for available nutrients

Nutrients	Fertility rating major nutrients		
	Low	Medium	High
Organic carbon (%)	<0.5	0.5-0.75	>0.75
Nitrogen (kg/ha)	<280	280 – 560	>560
Phosphorus (P ₂ O ₅) (kg/ha)	<22	22– 55	>55
Potassium (K ₂ O) (kg/ha)	<110	110 – 280	>280
Sulphur (kg/ha)	<20	20 - 40	>40
Micronutrients	Deficient	Sufficient	Excess
Zinc (mg/kg)	<0.6	0.6 – 1.5	>1.5
Iron (mg/kg)	<2.5	2.5 – 4.5	>4.5
Copper (mg/kg)	<0.2	0.2 – 5.0	>5.0
Manganese (mg/kg)	<2.0	2 – 4	>4.0

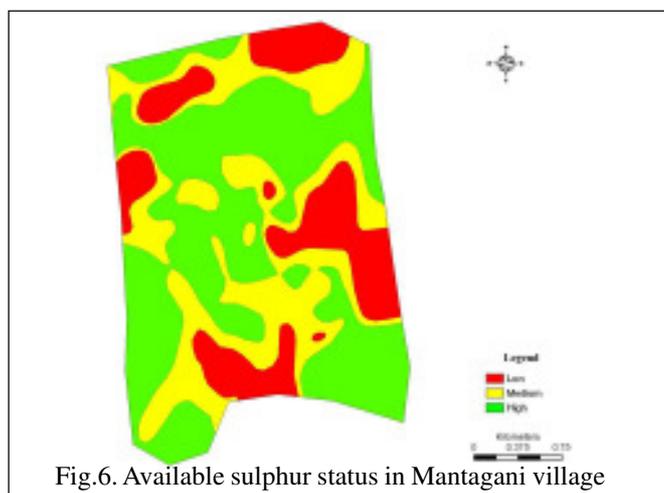
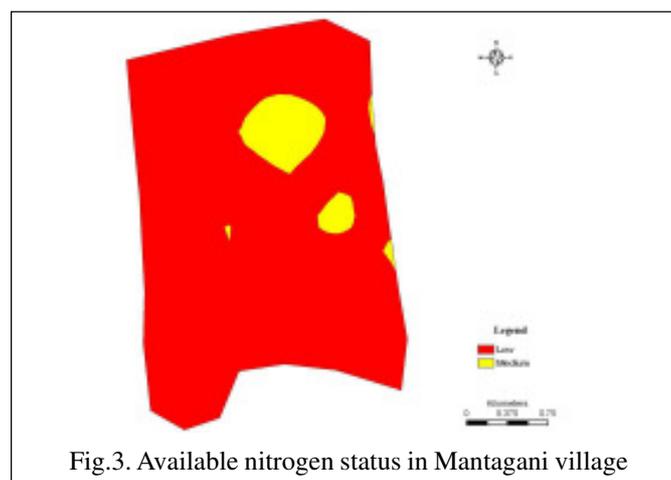
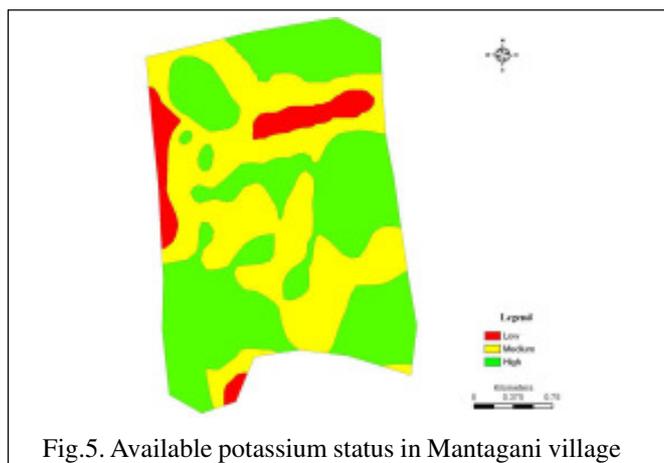
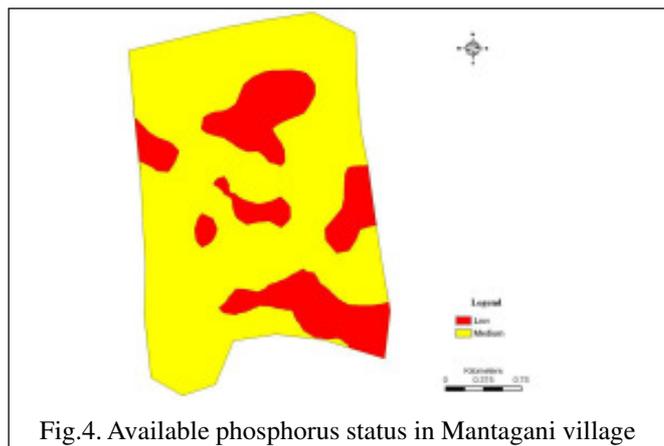
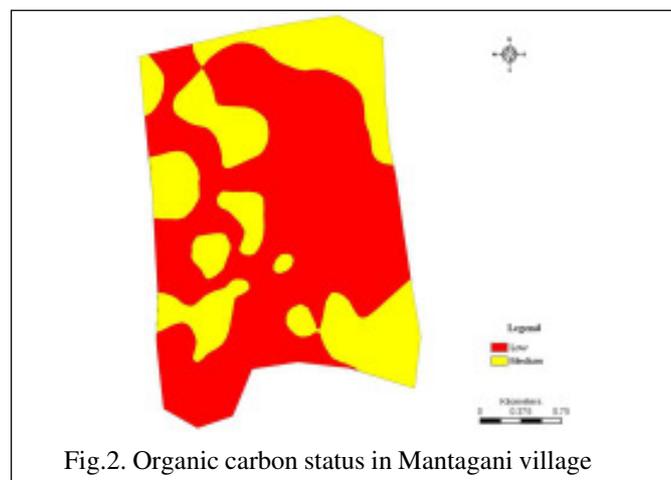


Table 2. Status of major nutrients in surface soil samples of Mantagani village

	Organic carbon (%)	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
Black soils				
Mean	0.45	205	28	305
SD	0.04	20.74	3.66	54.36
Range	0.36-0.58	79-303	21-35	202-417
Red soils				
Mean	0.55	232	17	207
SD	0.06	8.77	2.52	13.80
Range	0.47-0.58	221-244	14-21	187-227

Table 3. Status of secondary nutrients in surface soil samples of Mantagani village

	Calcium [cmol (p+)/kg]	Magnesium [cmol (p+)/kg]	Sulphur (kg/ha)
Black soils			
Mean	36	24	22
SD	3.51	3.18	5.56
Range	29.9-44.4	14.2-32.2	17.4-34.7
Red soils			
Mean	5	2	10
SD	2.44	0.76	0.88
Range	2.2-9.3	1.1-3.4	9.5-12.1

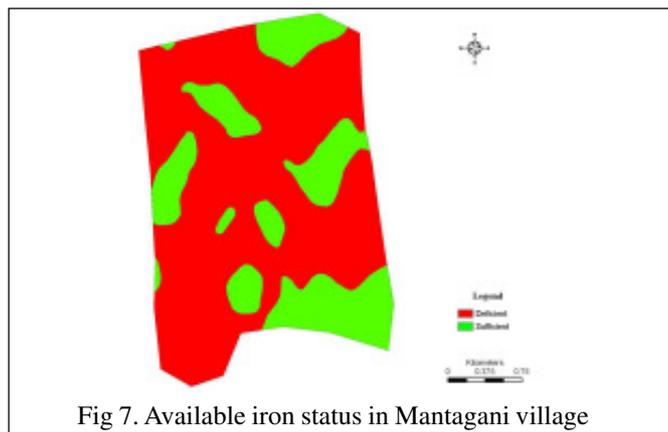


Fig 7. Available iron status in Mantagani village

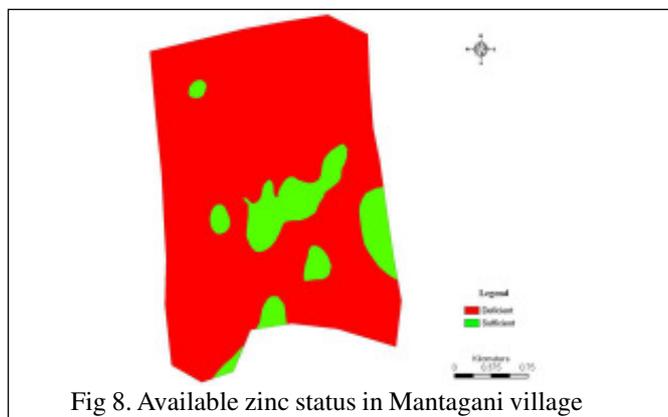


Fig 8. Available zinc status in Mantagani village

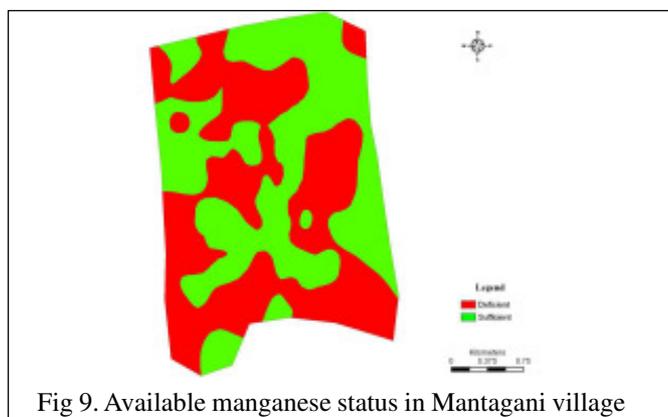


Fig 9. Available manganese status in Mantagani village

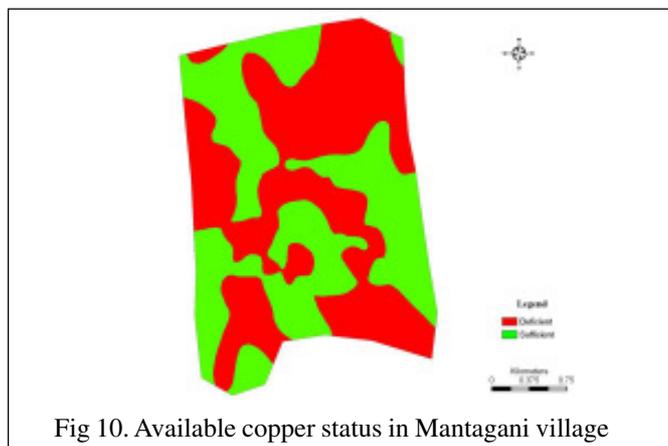


Fig 10. Available copper status in Mantagani village

Table 4. Status of available micronutrients (mg/kg) in surface soil samples of Mantagani village

	Iron	Manganese	Zinc	Copper
Black soils				
Mean	1.03	2.56	0.23	0.79
SD	0.56	2.07	0.62	1.19
Range	0.09-3.80	0.04-7.87	0.04-4.18	0.01-5.12
Red soils				
Mean	2.16	4.21	0.49	0.23
SD	1.03	3.05	0.37	0.18
Range	0.93-4.32	1.14-9.57	0.23-1.32	0.11-0.63

Table 5. Area (ha) under different categories for nutrients in Mantagani village

Nutrients	Fertility status		
	Low	Medium	High
Major nutrients			
Nitrogen	563	42	-
Phosphorus	144	461	-
Potassium	40	250	315
Sulphur	126	181	298
Micronutrients	Deficient	Sufficient	Excess
Zinc	531	74	-
Iron	435	170	-
Copper	326	279	-
Manganese	307	298	-
Total area (ha)	605.00		

179 to 303 kg ha⁻¹ and 221 to 244 kg ha⁻¹, respectively. Available phosphorus (P₂O₅) content ranged from 21 to 35 kg ha⁻¹ and 14 to 21 kg ha⁻¹ and that of Available potassium (K₂O) ranged from 202 to 417 and 187 to 227 kg ha⁻¹, respectively in black and red soils. Nagaraj (2001) and Ravikumar *et al.* (2007a) observed a similar trend of nutrient status in black soils of north Karnataka.

The major proportion of the study area was low in organic carbon and remaining area was medium in organic carbon. Low organic carbon in the soil was due to low input of FYM and crop residues as well as rapid rate of decomposition due to high temperature. The organic matter degradation and removal taken place at faster rate coupled with low vegetation cover thereby leaving less changes of accumulation of organic matter in the soil. These observations are in accordance with Govindarajan and Datta Biswas (1968).

The available nitrogen content was low in major portion of the study area (605 ha) which might be due to low organic matter content in these soils. Only in about 42 ha, available nitrogen was medium. The variation in N content may be related to soil management, application of FYM and fertilizer to previous crop. (Ashok Kumar, 2000). The total nitrogen content in the soils is dependent on temperature, rainfall and altitude. Another possible reason may also be due to low organic matter content in these areas due to low rainfall and low vegetation facilitate faster degradation and removal of organic matter leading to nitrogen deficiency. The medium nitrogen status in some area may be due to application of N fertilizer recommended for the crops.

The available phosphorus content was low in major parts of the study area (461 ha), where as, it was medium in 144 ha of the study area. The red soils were low in available phosphorus, which may be due to low CEC, low clay content and acidic soil reaction of <6.5 (Anon., 2003).

The available potassium content in major portion of the study area was in medium and high category. Black soils were higher in available potassium status than red soils which may be due to predominance of K rich micaceous and feldspars minerals in parent material. Similar results were observed by Ravikumar *et al.* (2007a). Major portion of area was under medium (250 ha) and low category (40 ha) of available potassium status in red soils, because these soils are coarser in texture. In addition, Kaolinite type of clay mineralogy may be the cause for their medium and low rating for available potassium.

The area under study was medium to low in available sulphur status with 181 and 126 ha, respectively. Low and medium level of available sulphur in soils of the area may be due to lack of sulphur addition and continuous removal of S by crops (Balanagoudar, 1989).

Major portion of the study area was sufficient in exchangeable Ca and Mg status. The deficiency of the exchangeable Ca contents was found in red soils, which may be due to easy leaching of bases and low organic carbon values. Anantharayana *et al.* (1986) reported higher exchangeable Ca and Mg contents in black soils than red soils.

Availability of calcium and magnesium to the crops do not generally present problems in black soils, as these soils are calcareous in nature. The exchangeable Ca and Mg are attributed to the type and amount of clay, present in these soils. These results are in confirmation with the findings of Alur (1994). High values of CEC and exchangeable Ca and Mg an indication of dominance of smectite type of clay mineral as reported by Nandi and Dasog (1992).

Available Zn status in black and red soils was deficient in the major portion of the study area. Since, the soils are alkaline and rich in CaCO₃, zinc may be precipitated as hydroxides and carbonates under alkaline pH range. Therefore, their solubility and mobility may be decreased resulting in reduced availability.

References

- Alur, A. S., 1994, Properties of red soils of agro-climatic zone-3 (region-II) of North Karnataka. *M. Sc. (Agri.) Thesis*, Univ. Agril. Sci., Dharwad (India).
- Anantharayana, R., Reddy, M. N., Mithyantha, M. S. And Perur, N. G., 1986, Status of available secondary nutrients in red soils of Karnataka. *J. Indian Soc. Soil Sci.*, 34 : 614-616.
- Anonymous, 2003, Malaprabha Command Area : Annual Progress report of AICRP on Water Managemenet, Belvatagi, Univ. Agril. Sci., Dharwad (India).
- Arora, C. L. and Sekhon, G. S., 1981, Influence of soil characters on DTPA extractable micronutrients cations in some soil series of Punjab. *J. Indian Soc. Soil Sci.*, 29 : 453-462.
- Arora, C. L., 2002, Analysis of soil, plant and Fertilizer. In: *Fundamentals of Soil Science* Published by Indian Society of Soil Science. pp 548.
- Ashok Kumar, S., 2000, Studies on soil aggregation in Vertisols of North Karnataka. *M. Sc. (Agri.) Thesis*, Univ. Agric. Sci., Dharwad (India).
- Balanagoudar, A. B., 1989, Investigation on status and forms of sulphur in soils of North Karnataka. *M. Sc. (Agri.) Thesis*, Univ. Agric. Sci., Dharwad (India).
- Govindarajan, S. V. and Datta Biswas, N. R., 1968, Characterization of certain soils in the sub-tropical humid zone in the south eastern part of Indian soils of Muchkand basin. *J. Indian Soc. Soil Sci.*, 16 : 117-186.
- Jackson, M. L., 1967, Soil Chemical Analysis, Prentice Hall of India Private Limited, New Delhi.

Similar results were also reported by Vijayshekar *et al.* (2000) and Ravikumar *et al.* (2007b).

Black soils were under deficient (435 ha) and sufficient category (170 ha) in available Fe status. Red soils were sufficient and excess in available Fe status. In black soils, low Fe content may be due to precipitation of Fe²⁺ by CaCO₃ and decrease the availability (Table.3). Similar results were also observed by Ravikumar *et al.* (2007b).

Major portion of the study area was deficient (326 ha) and some area was under sufficient status of available copper (279 ha). Raghupathi (1989) reported that available copper content in North Karnataka soils ranged from 0.4 to 1.2 ppm. Similar results were also observed by Ravikumar *et al.* (2007b).

In black and red soils, the available manganese was found to be sufficient in almost 50 per cent of study area and deficient in remaining fields, which may be due to neutral to low pH and nature of the parent material as reported by Prasad and Sahi (1989). Arora and Shekon (1981) reported that high pH calcareous black soils coupled with semi-arid conditions decreases the availability of Mn by converting into unavailable forms (Mn⁺⁺ converted Mn⁺⁺⁺). Sufficient content of manganese due to high organic matter content was observed in Upper Krishna Command Area by Vijayshekar *et al.* (2000).

From the study, it can be concluded that, soils of Mantagani village in northern transition zone of Karnataka were low in Soil organic matter content. Available nitrogen and phosphorus were low to medium and available potassium and sulphur were low to high. Regarding available micronutrients, zinc and iron were deficient whereas, copper and manganese were deficient to sufficient in these soils. Soil organic matter, available N, Cu, Fe and Zn were important soil fertility constraints indicating their immediate attention for sustained crop production. The deficient micronutrient may be replenished to avoid the crops suffering from their deficiency and for optimum utilization of other nutrients.

- Nagaraj, K., 2001, Studies on soils and their interpretative grouping under Distributary No. 18 in Malaprabha Command Area. *M. Sc. (Agri.) Thesis*, Univ. Agric. Sci., Dharwad (India).
- Nandi, S. and Dasog, G. S., 1992, Properties, origin and distribution of carbonate nodules in some Vertisols. *J. Indian Soc. Soil Sci.*, 40: 329-334.
- Prasad, S. N. and Sahi, B. P., 1989, Distribution of manganese in relation to soil properties in some typical soil profiles. *J. Indian Soc. Soil Sci.*, 37(3) : 567-570.
- Raghupathi, H. B., 1989, Investigation on soil copper and crop response in selected soils of Karnataka. *M. Sc. (Agri.) Thesis*, Univ. Agric. Sci., Dharwad (India).
- Ravikumar, M. A., Patil, P. L. and Dasog, G. S., 2007a, Mapping of Nutrients Status of 48A Distributary of Malaprabha Right Bank Command of Karnataka by GIS Technique. I-Major Nutrients". *Karnataka J. Agric. Sci.* 20(4): 735-737
- Ravikumar, M. A., Patil, P. L. and Dasog, G. S., 2007b, Mapping of Nutrients Status of 48A Distributary of Malaprabha Right Bank Command of Karnataka by GIS Technique. II-Micro Nutrients". *Karnataka J. Agric. Sci.* 20(4): 738-740
- Vijaya Sekhar, R., Vittal Kuligod, B., Basavaraj, P. K., Dasog, G. S. and Salimath, S. B., 2000, Studies on micronutrient status in important black soil series of UKP command, Karnataka. *Andhra Agril. J.*, 47: 141-143.
- Yeresheemi, A. N., Channal, H. T., Patagundi, M. S. And Satyanarayana, T., 1997, Salt affected soils of Upper Krishna Command Karnataka I. Physical and Chemical Characteristics. *Agropedology*, 7 : 32-39.