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Evaluation of Spatiotemporal Change of Micronutrient Status in Parts of National Capital Region (NCR) of Haryana State (India)

Priyanka Singh[1]*, Rani Devi[1] And R.S Hooda[2]

[1]Department Of Energy And Environmental Sciences
Chaudhary Devi Lal University (CDLU), Sirsa-125055, Haryana (INDIA)
[2]Chief Scientist, Haryana Space Application Centre (HARSAC-CCS, HAU-Campus) 125004

ABSTRACT

The present study was carried out to investigate the temporal and spatial distribution and dynamics of soil desurfacing due to brick kilns in some parts of National Capital Region (NCR) of Haryana state (India), using satellite Cartosat-I and Worldview-II digitized information and ground truth verification data for preparing area map and studying their impact on micronutrient status of agriculture land in study area (Rohtak district). The investigation revealed that micronutrient contents of desurfaced soils in this region have decreased drastically and was of the order of 78.40, 39.34, 31.74, and 55.21 % for Zn, Fe, Cu, and Mn, respectively. Brick kiln activities leading to soil desurfacing/surfacing mining in the region have been observed during 2007 and 2012 in a massive way, increasing little more than 40 % during this duration of five year, due to infrastructural development in the region.

KEY WORDS: Micronutrients, Brick kilns, Soil Desurfacing/Surface mining, Remote Sensing

*Corresponding author

Priyanka Singh

Research Scholar, Department of Energy and Environmental Sciences
Chaudhary Devi Lal University (CDLU), Sirsa-125055, Haryana (INDIA)
Email: priyanka201222@yahoo.com, rani_sahu@yahoo.com, hoodars@yahoo.com
M: 9416473645, 9416987345, 9416380644

1. INTRODUCTION

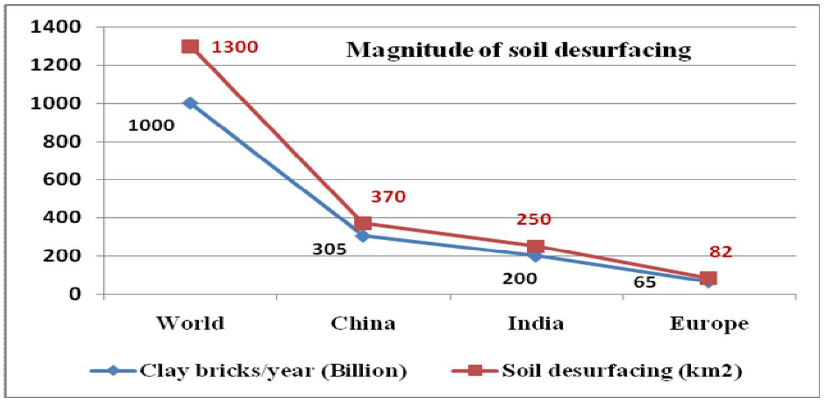

Fig. 1 ***Magnitude of soil desurfacing due to brick making around the world***

Use of fertile agriculture land for making bricks has become a common phenomenon particularly in fast growing rural and urban areas of the countries like India, China[1], and some parts of Europe. India produces 200 billion clay brick every year, inducing surface mining and degrading fertile land equivalent to 250 km² (25101 ha) per year, burning in kilns to manufacture clay bricks for construction.

The Indian brick kiln industry, which is the second largest producer in the world, second only to China, has approximately 150, 000 operating units all over the country,. The Gangetic plain of North India accounts for about 65% of the total brick production. Punjab, Haryana, Uttar Pradesh, Bihar, and West Bengal are the major brick producing states in this region. Nature takes about 1 million years to synthesize 25 cm of topsoil. Use of this surface soil for brick manufacturing destroys it permanently, this adversely affects the cultivation of the land, the flora and fauna and the environment around.

Fig.2 a Brick kiln activity in the study area

Fig.2 b Rampant soil desurfacing in study area

Desurfacing/surface mining exhibits immediate adverse impacts on the soil health and productivity, which is a matter of serious concern and needs immediate attention, particularly, for an agrarian state like Haryana, where agriculture is the main livelihood of more than 60% of the population. Haryana state is also one of the most important states of India contributing considerably (about 17 %) to the central pool of food grain production of the country,. Any damage to the fertile land may lead to devastating consequences in terms of decreased food grain production. The Haryana state has a total geographical area of 44056 km^2, 40 % of which falls in National Capital Region (NCR), is extremely prone to soil desurfacing due to brick kiln activity (Fig.2 a), reported to have a wasteland of 2347.05 Sq.km. Conversion of fertile land into wasteland by way of desurfacing is taking place unabatedly in national capital region (NCR) at a faster pace than expected due to increasing demand for construction material for the accomplishment of various housing and other construction projects.

1.1 Problem Statement

In this study, an attempt has been made to study the spatiotemporal dynamics of soil desurfacing/surface mining on the availability of micronutrients like zinc, iron, copper, and manganese in some parts of National Capital Region (NCR) of Haryana state (India). Especially, Rohtak district (study area) is highly engulfed in soil desurfacing/surface mining activity (Fig.2 b), due to its proximity to national capital, New Delhi, where infrastructural development due to urbanization and industrialization is increasing exponentially, Singh R.B. (2006)[2].

Remote sensing techniques and ancillary satellite database,[3] have proved very useful in assessing the area under soil desurfacing due to brick kiln activities, which constitutes large part of NCR of Haryana state (India). Following objectives have been envisaged to carry out present study.

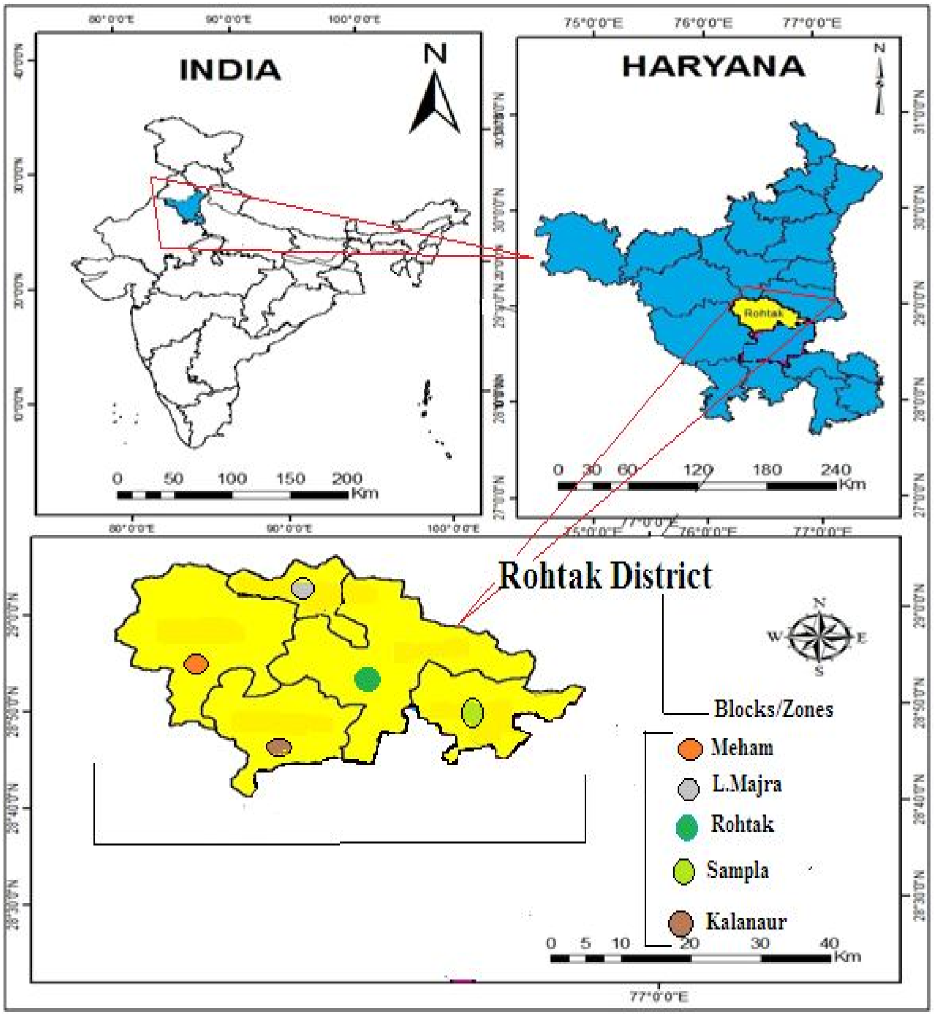

Fig. 3 ***Study area (Rohtak District)***

1.2 Objectives

- To study the temporal and spatial dynamics of soil desurfacing/surface mining on the extent of depletion and the availability of micronutrients like zinc, iron, copper, and manganese in the study area (Rohtak district), Haryana (India)
- Integration between remote sensing acquired data, ground truth observations and laboratory analytical results for assessing depletion pattern of micronutrients in the study area

2. MATERIALS AND METHODS

2.1 Location: Study area (Rohtak District) lays in 28^o 23´´ to 29^o 6´´ North latitude and 76^o 13´´ to 76^o 58´´ East longitude of the National Capital Region (NCR) of Haryana state (India). It is 70 km in northwest from national capital, New Delhi and located 235 km southeast of state capital, Chandigarh. More than 40 % area of Haryana state falls in NCR and whole of the study area is the part of NCR. Geographical area of study area is 1745 km^2. Study area is comprised of five community development blocks / zones (CDB), *viz*.1. Sampla 2. Kalanaur 3.Rohtak 4.Meham and 5.Lakhan Majra (Fig. 3)

2.2 Position of Study Area in Survey of India (SOI) Topographical Sheet: The study area covers the survey of India (SOI) topographical sheet No. 53C/8, 53C/12, 53D/01, 53D/5, 53 D/6, 53D/9, 53D/10, 53D/13, 53D/14 (Fig. 4). Map-Scale 1:25000

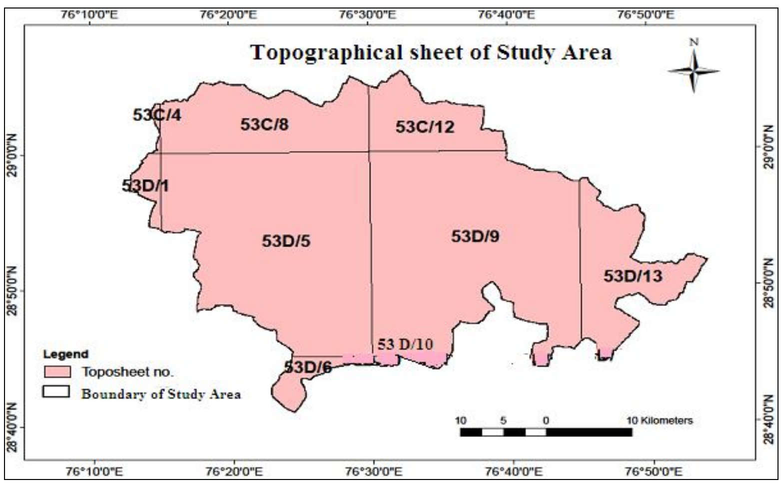

Fig. 4 Topographical Sheet Mosaic of study area

2.3 Satellite Details: Cartosat-I and worldview-II, have been installed with two set of sensors, PAN and Multispectral with resolution 2.5 m and 0.46 and 1.84 m, respectively, with a provision of single band and eight bands

Table 1: ***Satellite band and resolution specification of sensor***

Sr. No.	Satellite	Sensor	Resolution (m)	Band
1	Cartosat-I/(IRS-P5)	PAN	2.5	Single band (PAN)
2	Worldview-II	PAN & Multispectral	0.46 & 1.84	8 bands

Cartosat-I and worldview-II satellite gathered stereoscopic images with the help of sensors PAN and Multispectral in months at different dates as depicted in Table 2.

Table 2: ***Details of Satellite Data***

Sr. No.	Satellite	Sensor	Month of Acquisition	Number of Images
1.	Cartosat –I=Study area	PAN and Multispectral	17April 2007	1
			16 January, 2007	2
			27 February, 2007	2
			28 September, 2007	2
			12 December,	1
2.	Worldview-II=Study area	PAN and Multispectral	12 March, 2012	31
			12 April, 2012	25
			11May, 2012	73
			12 May, 2012	12
			11 October, 2012	7
			11December,2012	13

2.4 Data Acquisition and Use: Before the processing and classification of satellite imagery began, an extensive field survey was performed throughout the study area using Global Positioning System (GPS) equipment. This survey was performed in order to obtain accurate location point data for each land use / land cover class included in the classification scheme as well as for signature generation.

The topographic map (1:25,000 scale), data was acquired from Haryana Space Applications Centre (HARSAC)-Hisar-125004 (India), for the year 2007 and 2012. Multi-temporal and spatial geo-referenced Catosat-1 and Worldview-II satellite were used for present study. Generally, a vector layer is digitized over the raster scene. The vector layer consists of various polygons overlaying different land use types. The data obtained by on screen digitization is developed [4].

2.5 Geomorphology and Soil

The study area falls in eastern zone, which covers around 49 % area of the state. This zone is also called wet zone. More than 70 % of the rainfall received during southwest monsoon. Normal rainy days are >30 per annum. Mostly the land of this district is flat and plain. This is further manifested into additional three sub-units because of the Aeolian action in the Holocene period as (a) hummocky phase (fossils and dunes), (b) stabilized dunes / and sandy plains of recent times (c) dotted lack extension along the central track surrounded by waterlogged areas.

The area slopes towards northeast to southwest with an average gradient of 0.19 m / km. The general elevation ranges between 215-222 m from mean sea level. The soils of the district are fine to medium textured, sandy loam in Rohtak zone and Sampla zone, Lakhan Majra, loamy sand with occasional clay loam in Kalanaur and Meham zone. In Rohtak district (overall) high to medium content of potassium, medium to low phosphorus and nitrogen are low. Rohtak zone is part of Rohtak district.

2.6 Climate

Hot in summer, highest day temperature ranging between 23^{o}C - 45^{o}C. Sub-tropical, semi-arid, continental mainly rains bring by southwest monsoon in the season July - August- September. Rains are scanty to normal. The climate classified as tropical steppe, semi-arid and hot, which is mainly dry and hot with dry summer except monsoon months, *i.e*., July to September when moist air of oceanic origin penetrates into the land. Winters are also extremely cold and mostly dry where temperature falls to as low as 2-3^{o}C in winter nights. The mean seasonal temperature during *kharif* and *Rabi* season are 29-31^{o}C and 16-18^{o}C, with relative humidity of 70% and 55%, respectively.

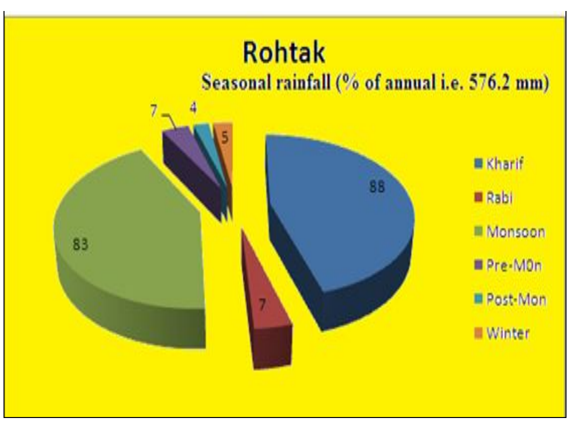

Fig. 5 Seasonal rainfall pattern in Rohtak district

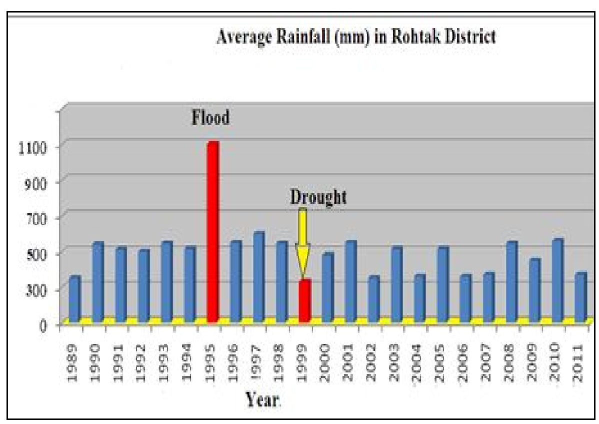

Fig. 6 Annual rainfall pattern (year wise) in Rohtak district

There are four seasons in a year. The hot weather season starts from mid March to last week of June, followed by southwest monsoon lasting up to September. The transition period from September to October forms the post monsoon period (Fig. 5). The winter sets in first week of November and remains up to first week of March. The normal annual rain is 576.2 mm, which is unevenly distributed throughout the year (Fig. 5). The southwest monsoon sets in from last week of June and withdraws in the end of September, contributing about 85 % of the rainfall. July and August are the wettest months. Rest of the 15 % rainfall received in non-monsoon period of the year in the wake of western disturbances and thunderstorms. Generally, the rainfall of the district increases from southwest to northeast. Highest rainfall recorded in the year 1995, which brought lot of water logging problem in the district, creating flood like situation in some of the parts of the district. Lowest rainfall was in the year 1999, responsible for draught like situation in the district (Fig. 6).

The natural vegetation in the district is mainly *Acacia arabica*, eucplitus, neem (*Melia*), *peepal*, *baniyan tree* (*Ficus religiosa*), *etc*. The major crops grown in the district are wheat, paddy, mustered, cotton, sugarcane, *jawar (soghum)*, *etc*. Near town, vegetable crops are also grown frequently. Horticulture crops like *guava*, *kinnow*, and *ber* also grown on good soils.

2.7 Methodology Used

1. Cartosat-I, and Worldview-II satellite images for the year 2007 and 2012 is used to identify and map desurfaced soils in Rohtak district as depicted in Fig.7a and b respectively. The red spots are depicting the desurfaced soil formation in study area. This digitized data has been taken from already published paper by Singh *P.et.al* (2014)[9]. This layer of brick kilns is laid down on the land use map to see the change due to soil desurfacing and found the percent change.

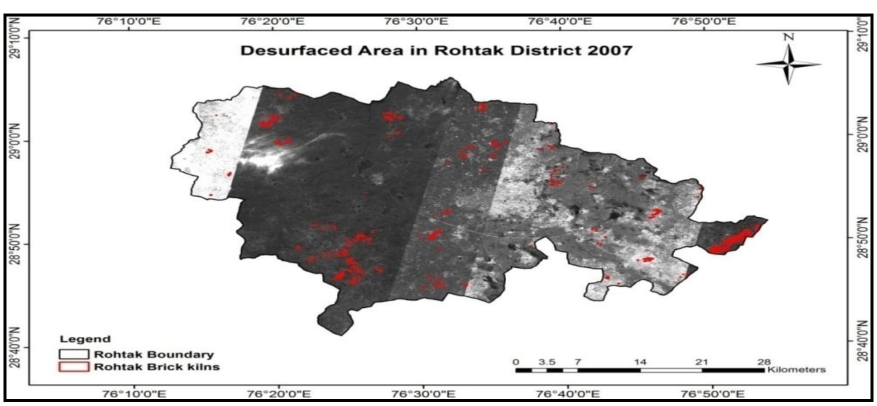

Fig.7 Desurfaced area in Rohtak District (2007)

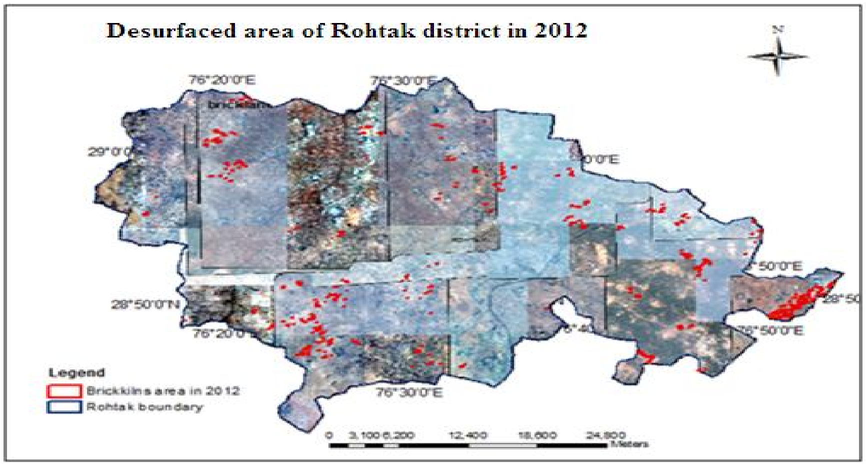

Fig.8 Desurfaced area in Rohtak District (2012)

Table 3 ***Desurfaced area status of Rohtak district in 2007 and 2012***

S.No.	District	Desurfaced Area(DA) Status						% Change in desurfaced area in 5 years
		2007			2012			
		No. of Brick kilns	DA (ha)	% Geographic Area	No. of Brick kilns	DA (ha)	% Geographic Area	
1.	Rohtak	80	629.3	0.36	106	888.8	0.51	41.23

2.8 Area Calculation and Clipping of the BlocksZones

Attribute table of the shape file opened and then new field added to the table, name and type provided for the same. Area of polygons initially was calculated in square meters and then converted into hectares. To see temporal and spatial physical changes, the district was divided into different blocks/zones. The boundary of different blocks/zones of Rohtak district was exported. Then the boundary of each block/zone of the district was clipped with the shape file of the desurfaced soil of 2007, cartosat-I image and 2012 worldview-II image as shown in Fig. 7 - 8. When we clip the boundary of all the blocks with the shape file of the desurfaced soil then the attribute table of each block/zone will give the area of desurfaced soil in the respective block/zone.

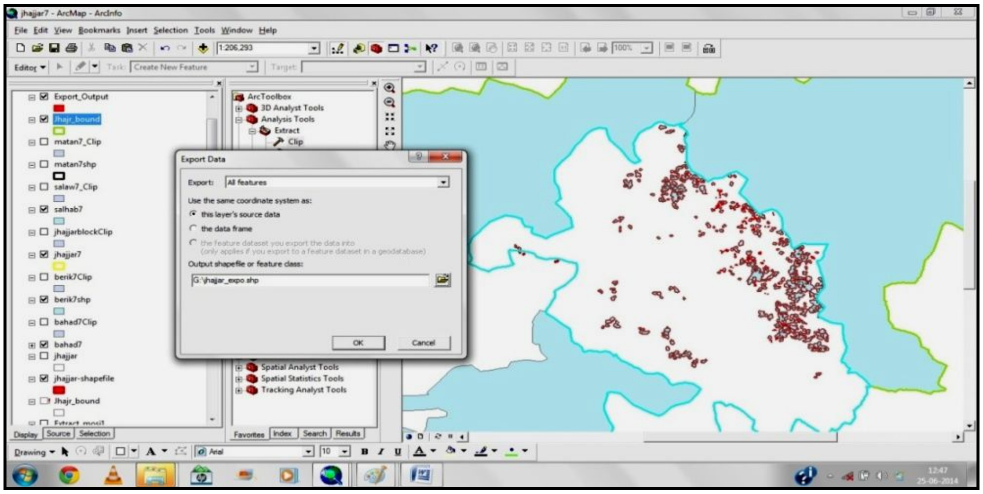

Fig. 9 Clipping of different blocks of Rohtak district

Then this data taken to MS-EXCEL the total area in each block/zone is calculated by doing auto sum. When all the area obtained, then graph plotted for the years 2007 and 2012 and area of the blocks/zones of Rohtak district in hectares.

2.9 Block/Zone Level Mapping of Desurfaced Soils

In Fig. 10, the Rohtak geographical area has been divided into various blocks/zones demarcating boundary of each block. The blue spots in the Fig. 10 show desurfaced soil area in different blocks/zones of Rohtak district in the year 2012. Sampla block was found having the highest area under desurfacing process, followed by Kalanaur, then Rohtak, Meham and Lakhan Majra with lowest in the year 2012, Table 4.

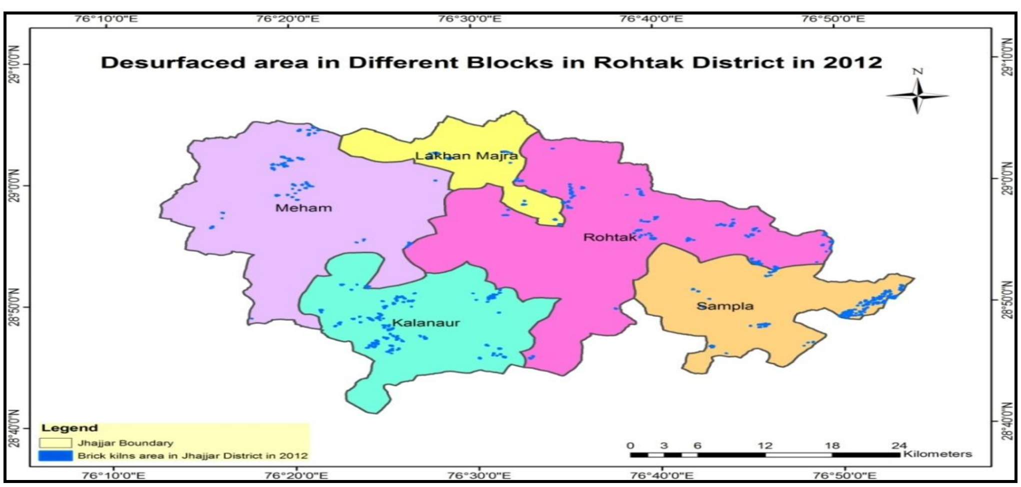

Fig. 10 Map of Rohtak District showing desurfaced area in 2012

Table 4 *Block Wise / Zone Wise Depiction of Desurfaced Area in Rohtak District*

S.No.	Block/Zone	Block/Zone wise Desurfaced Area (ha)				% Change in desurfaced area in 5 year duration
		2007		2012		
		Total Area (ha)	% Geographic Area	Total Area (ha)	% Geographic Area	
1.	Sampla	207.46	0.12	344.61	0.20	+66.11
2.	Kalanaur	206.45	0.12	211.20	0.12	+2.30
3.	Rohtak	100.95	0.06	181.85	0.10	+80.14
4.	Meham	78.14	0.04	105.90	0.06	+35.52
5.	L.Majra	36.28	0.02	45.24	0.02	+24.69
	Total	629.30	0.36	888.800	0.51	+41.23

+ Sign indicates increase in soil desurfaced area in five years duration (2007 - 2012) in respective blocks/zones

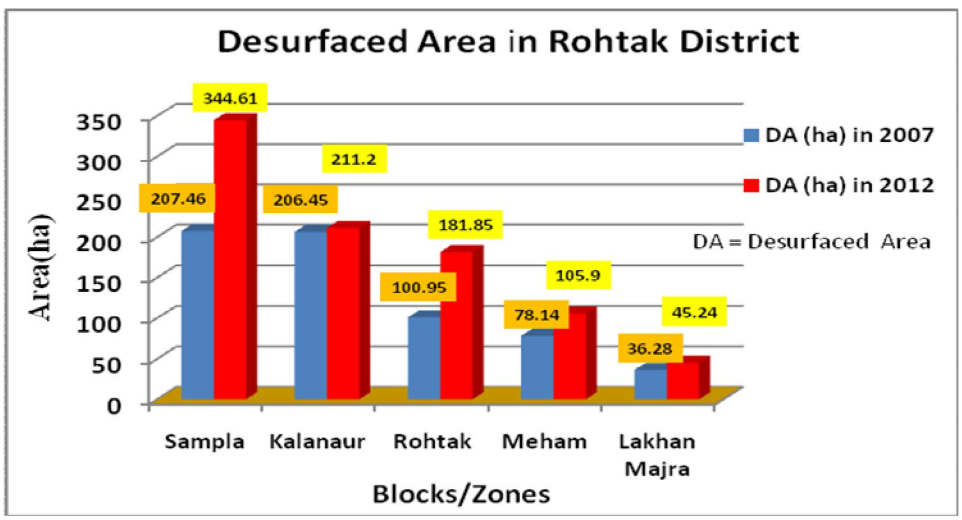

Fig. 11 Spatiotemporal change in desurfaced area in Rohtak district (2007- 2012)

Graphical representation of spatiotemporal changes in Fig. 11 clearly indicates that in all the blocks/zones of Rohtak district have registered increasing trend in the formation and area under soil desurfacing due to brick kiln activity. Higher desurfaced area observed in Sampla block/zone in the year 2012, which is significantly higher than the year 2007, Kalanaur block/zone was the second highest followed by Rohtak block/zone and then Meham with medium and Lakhan Majra with lowest. Sampla block/zone is in close vicinity of national capital, New Delhi, providing bigger brick market for the supply of raw material; providing more opportunities to the brick manufacturers for expanding their business as per the demand, hence more area of agriculture land coming under desurfaced soil category. Sampla block/zone having the highest (39%) area under soil desurfacing, followed by Kalanaur (24%), then Rohtak (20%), Meham (12%) and Lakhan Majra (5 %) the lowest, in the year 2012.

2.10 Ground Truth Points of Investigation Sites (TABLE 5):

Values of GPS as indicated in table below block / zone wise of study area from where soil samples were collected (Fig. 12) for further soil analysis to assess micronutrient status of the soil. Ground truth verification was also conducted simultaneously of soil desurfaced area and brick kiln activities in the region.

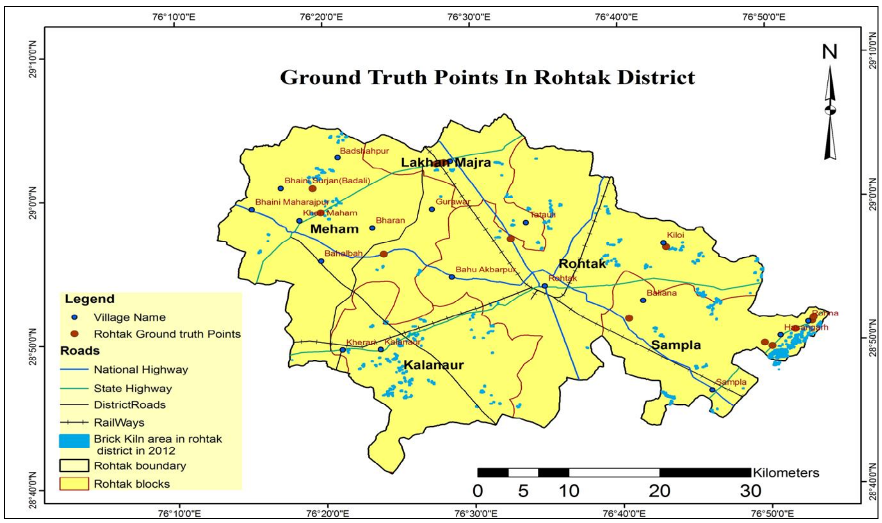

Fig. 12 Ground truth points and sampling sites

Table 5: ***GPS locations of sampling sites (Ground Truth Points)***

No.	Location Block wise / Zone wise	Latitude	Longitude
1	Meham	N 28° 59′8.52″	E 76° 19′45.228″
2	Lakhan Majra	N 29° 02′29.148″	E 76° 27′37.512″
3	Rohtak	N 28° 56′32.208′	E 76° 43′5.628″
4	Sampla	N 28° 49′48.612″	E 76° 49′40.548″
5	Kalanaur	N 28° 51'.592"	E 76° 40'.520"

- Detailed ground truth verification was conducted based on remote sensing observations.
- Identification of desurfaced soils in the study area (Rohtak district, part of NCR) with the help of IRS/P-5/Cartosat-I and Worldview-II, high-resolution satellite and imageries used, available at Department of Haryana Space Applications Centre (HARSAC)-Hisar, during the period 2007-2012.
- Ground Truth Survey / field verification was conducted to ascertain the accuracy of the identified details. Latitude and longitude values obtained from the GPS, converting into degree decimals and excel table was prepared accordingly. Table-5 shows the latitude / longitude values of GPS points block wise / zone wise from where soil samples were taken during the ground truth survey of the study area.

2.11 Soil Sampling

Soil sampling and Ground Truth Survey were conducted simultaneously in all blocks/zones (Community Development Block / Zone) of the study area. Soil sampling was done using randomized soil sampling technique

3.0 STATISTICAL ANALYSIS

Statistical analysis of data performed using online Statistical Analysis Tools-OPstat, applied for various observations using randomized soil sampling technique and effects compared using least significant differences ($LSD_{0.05\ and 0.01}$), Standard deviation, and Mean values (Table 6).

Table 6: ***Statistical Description and Comparison of Normal and Desurfaced Soil in Study Area***

Micronutrients	Land-Surface	Mean	S.D	t-Value
Zn	Normal	2.6311	1.68633	3.595**
	Desurfaced	.5944	.21208	
Fe	Normal	11.0711	15.97129	1.352*
	Desurfaced	7.5878	9.42178	
Cu	Normal	1.75441	1.02273	1.132*
	Desurfaced	1.3478	.95052	
Mn	Normal	9.5922	7.15801	1.418*
	Desurfaced	5.9433	2.92271	

** Significant at $LSD_{0.05}$, ** Significant at $LSD_{0.01}$*

4.0 RESULTS AND DISCUSSION

4.1 Micronutrient status zone wise

Enormous depletion of Zn content in desurfaced soil observed as illustrated in Fig. 13 as compared to normal, Grewal and Kuhar (2002)[5] soil and highly pronounced decrease was of the order of 78.4 % due to desurfacing process, Bramble-Brodhal, *et.al.* (1985)[6].

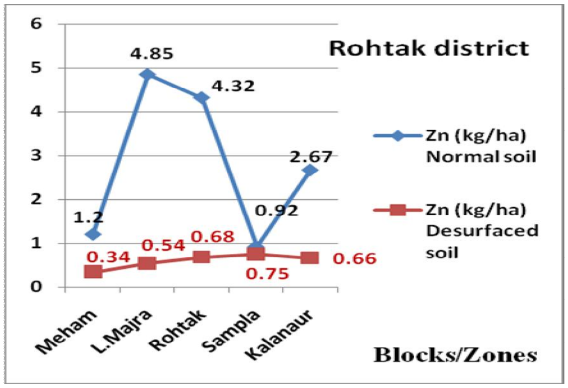

Fig. 13 Zn content in normal and desurfaced soil of study area zone wise

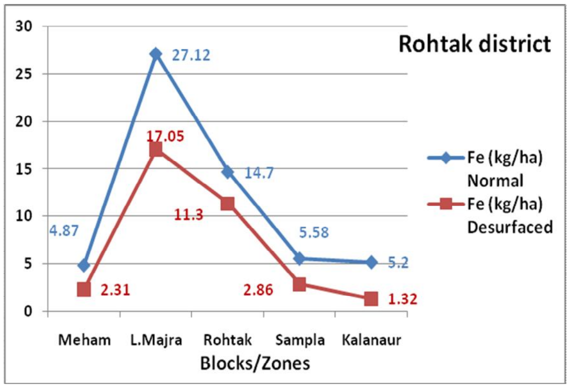

Fig.14 Fe content in normal and desurfaced soil zone wise

Statistical results have revealed that the decrease of Zn in desurfaced soil as compared to normal soil due to spatial variability, [7]and[8]. is highly significant at $LSD_{0.01}$.

Meham block/zone, normal soil had 1.20 Zn kg ha^{-1} and desurfaced soil 0.34 Zn kg ha$^{-1,}$ Lakhan Majra block/zone, normal soil had 4.85 Zn kg ha^{-1}, and desurfaced soil 0.54 Zn kg ha$^{-1,}$ Rohtak block/zone, normal soil had 4.32 Zn kg ha^{-1}, and desurfaced soil 0.68 Zn kg ha$^{-1,}$ Sampla block/zone, normal soil had 0.92 Zn kg ha^{-1}, and desurfaced soil 0.75 Zn kg ha$^{-1,}$ and Kalanaur block/zone, normal soil Zn 2.67 kg ha^{-1}, and desurfaced soil 0.66 Zn kg ha^{-1},respectively, (Fig.13).

Meham block/zone, normal soil had 4.87 Fe kg ha^{-1} and desurfaced soil 2.31 Fe kg ha$^{-1,}$ Lakhan Majra block/zone, normal soil had 27.12 Fe kg ha^{-1}, and desurfaced soil 17.05 Fe kg ha$^{-1,}$ Rohtak block/zone, normal soil had 14.70 Fe kg ha^{-1}, and desurfaced soil 11.30 Fe kg ha$^{-1,}$ Sampla block/zone, normal soil had 5.58 Fe kg ha^{-1}, and desurfaced soil 2.86 Fe kg ha$^{-1,}$ and Kalanaur block/zone, normal soil 5.20 Fe kg ha^{-1}, and desurfaced soil 1.32 Fe kg ha^{-1},respectively, (Fig.14).

Meham block/zone, normal soil had, Cu 1.55 kg ha^{-1} and desurfaced soil Cu 1.00 kg $ha^{-1,}$ Lakhan Majra block/zone, normal soil had, Cu 2.05 kg ha^{-1}, and desurfaced soil Cu 1.20 kg $ha^{-1,}$ Rohtak block/zone, normal soil had Cu 3.11 kg ha^{-1}, and desurfaced soil Cu 2.80 kg $ha^{-1,}$ Sampla block/zone, normal soil had, Cu 1.61 kg ha^{-1}, and desurfaced soil Cu 0.91 kg $ha^{-1,}$ and Kalanaur block/zone, normal soil Cu 1.13 kg ha^{-1}, and desurfaced soil Cu 0.53 kg ha^{-1},respectively, (Fig.15).

Meham block/zone, normal soil had, Mn 19.60 kg ha^{-1} and desurfaced soil, Mn 7.72 kg $ha^{-1,}$ Lakhan Majra block/zone, normal soil had Mn 5.45 kg ha^{-1}, and desurfaced soil, Mn 2.82 kg $ha^{-1,}$ Rohtak block/zone, normal soil had Mn 3.85 kg ha^{-1}, and desurfaced soil Mn 1.90 kg $ha^{-1,}$ Sampla block/zone, normal soil had, Mn 4.86 kg ha^{-1}, and desurfaced soil Mn 2.34 kg $ha^{-1,}$ and Kalanaur block/zone, normal soil, Mn 11.36 kg ha^{-1}, and desurfaced soil Mn 5.41 kg ha^{-1},respectively, (Fig.16).

Fig.14 reveals that Lakhan Majra zone recorded the highest Fe content (27.12 kg ha^{-1}) and lowest in Meham zone (4.87 kg ha^{-1}) in normal soil, where as in desurfaced soil Lakhan Majra (17.05 kg ha^{-1}) and Kalanaur with lowest Fe content (1.32 kg ha^{-1}), significant at $LSD_{0.05}$.

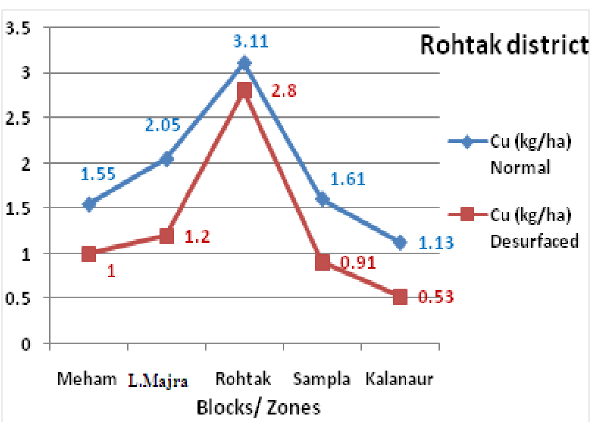

Fig.15 Cu content in normal and desurfaced soil zone wise

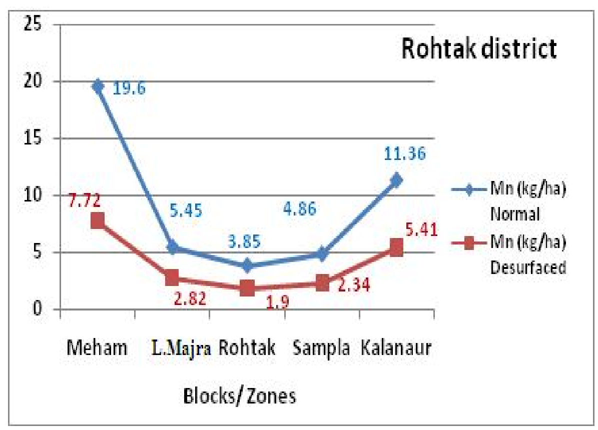

Fig.16 Mn content in normal and desurfaced soil zone wise

Fig. 15 depicts Cu content in normal and desurfaced soil of Rohtak district zone wise. Highest Cu content in normal soil of Rohtak zone (3.11 kg ha^{-1}), followed by Lakhan Majra (2.05 kg ha^{-1}) and lowest in Kalanaur zone (1.13 kg ha^{-1}) of Rohtak district. In desurfaced soil, Rohtak zone has the highest Cu content (2.8 kg ha^{-1}), followed by Lakhan Majra (1.2 kg ha^{-1}) and Meham (1.0 kg ha^{-1}), and Sampla and Kalanaur with 0.91, 0.53 kg ha^{-1}, respectively.

Fig. 16 illustrates that Meham zone normal soil had higher content of Mn (19.60 kg ha^{-1}), followed by Kalanaur (11.36 kg ha^{-1}) and lowest recorded in Rohtak zone (3.85 kg ha^{-1}) of Rohtak district. In desurfaced soil, there was abrupt decline of Mn content in all the zones and significant at $LSD_{0.05}$.

Desurfacing/surface mining, [9]. Topsoil carries away considerable soil organic matter, in which much of the potentially available micronutrients are held, [10]. Also, removal of topsoil exposes sub soil that are often higher in pH than the topsoil, a condition that leads to restricted availability of the micronutrients, such as Zn, Fe, Cu and Mn. Desurfaced soils are commonly known for micronutrient deficiency.

Micronutrients are becoming increasingly important to world agriculture as crop removal of these essential elements increases, as the farmers are using high yielding varieties of crops to increase production, [11]. Soil and plant tissue tests confirm that these elements are limiting crop production over wide areas and suggest to give due attention to micronutrients application. Micronutrient deficiencies are due not only to low contents but more often to the unavailability to growing plants. They are adsorbed by inorganic constituents like Al oxides, calcite and silicate clays, and become sparingly available to plants, [12].

All the micronutrients present in varying quantities in igneous rocks. Organic matter is an important secondary source of some of the trace elements. Several of them tend to held as complex combinations by organic colloids (humus). This is the reason due to soil desurfacing when organic matter is lost, soil become deficient in micronutrients. Removal of topsoil resulting into reduction of organic matter massively, [13and14]. On the organic matter, the metal binding sites are more selective for Cu than for Zn. The reactions with organic matter and amorphous Fe are major controls on Cu sorption. High content of calcite and dolomite in sub horizons further decreases zinc availability, because zinc is tightly adsorbed to dolomite and calcite particles, abundantly present in sub horizons of Rohtak district soils, aggravating micronutrient depletion further.

Presence/dominance of silicate clays at lower horizons due to migration process, micronutrients specially zinc interacting with these silicate clays, converting this element into unavailable form and inducing zinc deficiency.

Depletion of Zn content in desurfaced soil/surface mined soil is more pronounced as compared to normal soil and trend was of the order of 78.40 % (Mean value of all zones combined at district level), very close to critical limit *i.e*. (1.2 kg ha^{-1}/ 0.6 ppm).

Fe decreased by 39.34 %, Cu by 31.74 % and Mn by 55.21 % respectively in desurfaced soil as compared to normal soil (Fig. 17), [15].

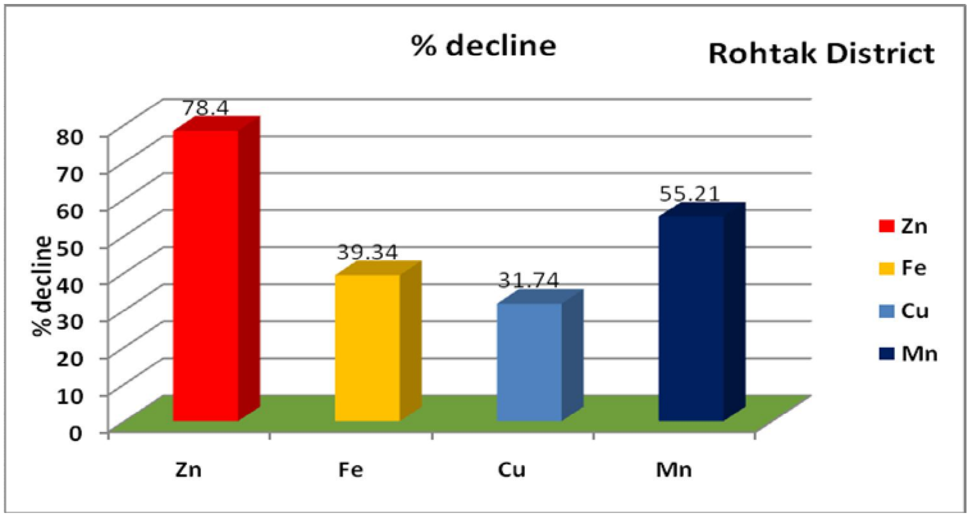

Fig. 17 Percent decrease of Zn, Fe, Cu, and Mn in study area

The uptake of both Zn and Fe may be reduced in the presence of excess of phosphates, [16]and [17].

5. CONCLUSIONS

Study demonstrates that soil desurfacing has invariably depleted the contents of essential micronutrients like zinc, iron, copper, and manganese in all the zones of Rohtak district, which were chosen for conducting present study.

Decreasing order of micronutrients in desufaced soil of study area**:**

- Zn: Decreased by 78.40 % due to soil desurfacing in study area as compared to Normal Soil
- Fe: Decreased by 39.34 % due to soil desurfacing in study area as compared to Normal Soil
- Cu: Decreased by 31.74 % due to soil desurfacing in study area as compared to Normal Soil
- Mn: Decreased by 55.21 % due to soil desurfacing in study area as compared to Normal Soil

The remote sensing (RS) data coupled with soil analytical and field based data found to be useful in proper planning for management of desurfaced soil. Interpretation mapping of satellite data is basic and essential requirement for management of degraded soil, and to further check the desurfacing process in more prone zone like Sampla being in very close proximity of national capital, Delhi.

REFERENCES

1. Zhang M.K., and Fang L.-P. Effect of tillage, fertilizer and green manure cropping on soil quality at an abandoned brick making site, *Soil &Tillage Res.*, 2007; 93: 87-93.
2. ISRO, Department of Space, Atlas of India, 2006
3. Singh R.B. Brick Kiln Industry as Drivers of Land Use Change and Related Land Degradation in Rural-Urban Fringe of Delhi. *Sust. Urban Dev.*, ISBN 10: 8180692957. 2006.
4. Jensen J.R. Remote Sensing of the Environment: An earth resource perspective 2nd edition ISBN 13:978-0131889507, 1996; 19.
5. Singh P., Rani D., Hooda R.S. *et. al.* Map and Identify Desurfaced Soils in Rohtak and Jhajjar District in Last Five Years Using RS, *IJESE*, ISSN: 2319-6368. 2014; 2 (4).
6. Grewal M.S. and Kuhar M.S. Soil Desurfacing-Impact on Productivity and its Management, Deptt. Soil Sci., Chaudhary Charan Singh-Haryana Agricultural University (CCS-HAU), Hisar- 125004, India. *12th ISCO Conference Beijing, 2002.*
7. Bramble-Brodhal M., Forsberg M.A., Walker D.L. *et. al.* Changes in Soil productivity related to changing top soil depth on two Idaho Palouse soils. International Symposium "*Erosion and soil productivity*" ASAE Publ. 8-85. ASAE, St. Joseph.MI. 1985.
8. Singh J.P., Karamanos R.E., and Kachanoki R.G. Spatial variability of extractable micronutrients in a cultivated and native Prairie soil. *Can. J. Soil Sci.*, 1985; 65:149-165.
9. Khan M.A., and Nortcliff, S. Variability of selected soil micronutrients in a single soil seriesin Birkshire, England. *J Soil Sci.*1982; 33**:**763-770.
10. Indorante S.J; Jansen I.J; and Boast C.W. Surface mining and reclamation, Initial changes in soil character. *J. Soil Water cons.* 1981; 36: 347-350
11. Sillanpäa M. Micronutrients and the nutrient status of soils: a global study. FAO Soil Bull. No. 48 1982; 444
12. Agbenin J.O, and Olojo L.A. Competitive and adsorption of copper and zinc by a Bt horizon of a savanna Alfisol as affected by pH and selective removal of hydrous oxides and organic matter. *Geoderma* 2004; 119: 85-95.
13. Gollany H.T; Shcumacher T.E; Evenson P.D. *et.al.* Aggregate stability of an eroded and desurfaced Typic Agriustoll, *Soil Sci. Soc. Am J.* 1991; 55*:811-816.*

14. Gollany H.T; Schumacher T.E; Evenson P.D.*ea. al*. To soil depth and desurfacing effects on properties and productivity of a Typic Agriustoll. *Soil Sci. Soc. Am J.* 1992; 56: 220-225.
15. Welch R.M. Micronutrients nutrition of plants, Critical Review in *Plant Sci*. 1995; 14(1): 49-82.
16. Mortvedt P.M., Geordane and Lindsay W. L (eds). Micronutrients in agriculture *Soil Sci Soc Am* Madison, Wis. USA. 1972; 666.
17. Safaya N.M. and Singh B. Differential Susceptibility of Two Varieties of Cow Pea, *Plant and Soil (Nethrlands)*. 1977; 48 (2): 279-290.