Anatomization of Soil Fertility Status of Chaka Block, Yamuna River Bank, Prayagraj, Uttar Pradesh, India

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Original Research Article

ABSTRACT

The present investigation was carried at Sam Higginbottom university of Agriculture Technology and Sciences in the department of Soil Science and Agricultural Chemistry lab. In this study, a total of 24 soil samples were collected from eight different villages on 01 November 2020 in Chaka block of Prayagraj district and from each village 3 soil samples were collected and analyzed for their Physico-chemical parameters by using standard laboratory techniques. According to the critical limits of soil nutrients the results observed, 70 to 80% soil samples were in low to medium range for Nitrogen (N) (51-648 kg ha^{-1}), Phosphorus (P) (0 – 48 kg ha^{-1}) and Potassium (K) (78.4 – 392 kg ha^{-1}). The micro-nutrients (Zn, Fe, Mn, Cu) of soil samples are observed deficiency range due to inverse relationship with pH i.e., increase in pH causes reduction in availability of Zn, Fe, Mn, Cu. According to the Nutrient Index Values, Chaka block was found to be medium category for Organic carbon (2.25), Nitrogen (1.70), Phosphorous (2.29), and Manganese (1.70). Low

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category was found in Potassium (1.37), Sulphur (1.29), Zinc (1.08) and Iron (1.41). High category was found in Copper (2.66). The results showed that improvement has to be done for improving soil fertility and quality by practicing the improving cropping pattern, decomposition of organic waste, mulching and tillage practices.

1. INTRODUCTION

Soil is the natural resources which need to be scientifically utilized for improving the productivity and economic condition of the country. Soil is the thin layer on earth surface which is formed before the drawn of human civilization and it regulates the nutritional status by that means reach the socio-economic condition of any biosphere. The capacity of soil to function as living ecosystem to sustain plants, animals and humans referred as soil health. The healthy soil gives us clean air and water, crops and forest, grazing lands, diverse wildlife and magnificent landscape and it perform major five functions such as regulating water, snowmelt and irrigation water movement, sustain living organism's life and buffering potential pollutants, cycling nutrients- nitrogen, phosphorous, carbon and other nutrients are stored and transformed (USDA U.S. Salinity Laboratory Staff) [1].

Soil fertility management is effective tools for increasing productivity of agricultural soil that has high degree of spital viability from the combined effects of physical, chemical and biological processes [2]. The Fertility status of the soils of an area or region is an important aspect for sustainable agricultural production whereas Nitrogen, Phosphorus and Potassium are major soil nutrient elements that control its fertility and yields of crops. There are 16 essential elements for plant growth absence of any one nutrient it will render the crop production. The essential plants nutrients are classified into Macro and Micro nutrients such as N, P, K, Ca, Mg, S and Cu, Fe, Mn, B, Zn…*etc.* Soil consists Nitrogen in forms of N_2O, NO, NO_2, and NH_3. It is the essential constituent of all living matter like chlorophyll, protoplasm, protein and nucleic acids and it also found in other compounds of plant metabolism like: Nucleotides, Phosphatides, alkaloids, enzymes, hormones, vitamins *etc.* Phosphorus is a limiting nutrient in the soil which goes for fixation and it plays vital role in photosynthesis, respiration, energy storage, cell division, cell elongation, promotes early root formation and growth. Calcium plays a major role in neutralizing the charges on the acidic

molecules of phosphoric acid and organic acid which are injurious to plants. Magnesium is a component part of chromosomes and polyribosomes and it is a mineral constituent for chlorophyll. Sulphur plays major role for formation of plant protein because it is a part of certain amino-acids which acts as building blocks of proteins.

In Uttar Pradesh most of area is covered by deep layer of alluvial soil spread by rivers of ganga system. The fertility range of alluvial soil from sandy to clayey loam where southern part of Uttar Pradesh soil is mixed red and black or red-to-yellow. The distribution of total geographical area of Uttar Pradesh is 29,441 ha in that soil are categorized in different soil orders were 415 ha belongs to vertosols, 83 ha Mollisols, 1,793 ha Alfisols, 21,490 Inceptisols, 4,813 Entisols and 848 ha are other soil orders [3]. Rivers are precious elements of nature its play's major role in integrating and organizing the landscape [4]. Yamuna originated from Yamunotri glacier of Uttar kashi it is second largest tributary river ganga and important river of India It flows through the states of Delhi, Haryana, and Uttar Pradesh were merges with ganga at Triveni Sangam, Prayagraj. The total length of river is around 1,370 kilometers with a total drainage of 366,220 Sq kilometers. Approximately, 57 million people are depending on the river for their basic need in entire Yamuna basin 12.3 million hectares are irrigated and 49% of land is irrigated from surface water [5].

2. MATERIALS AND METHODS

2.1 Study Area

Chaka is a block in Prayagraj district of the Indian state in the Southern part of Uttar Pradesh at an elevation of 98 meters (322 ft). Prayagraj is also a metropolis city in the Indian state of Uttar Pradesh. It is located at 25.45^0 N and 81.84^0 E and lies 102m above the mean sea level. The geographical area of the district is 5437.2 Sq.kms (as per 1991 data). Prayagraj comes under three agro-climates zones are Agro-climate zone-IV, Middle Gangetic plains region

Agro-climate Zone-V and Upper Gangetic Plains region and Agro-climate Zone-VIII. Prayagraj district consists of 7 Tehsils, 20 locks, 218 Nyaya panchayats, and 1472 Gram panchayats. The place shows a humid subtropical climate with temperature varies from 10^0c to 28^0c in winters and 23^0c to 42^0c in summer and annual rainfall is 981mm. The major crops grown are Paddy, wheat, Barley and jowar.

2.2 Analysis of Physico-chemical Parameters

Total 24 surface soil composite samples were collected from eight different villages, and each village 3 surface soil samples were collected in different sites in chaka block, Prayagraj district, Uttar Pradesh. At first stones litter and twigs were removed from sampling place and with the help of soil auger the soil was digged up to 15cm depth. From each field 4-6 representative sub-samples were collected in the form of zigzag manner. Approximately about 3-4 kg of soil sample was collected and spread on the large sheet and mixed it order to make soil homogenous once the mixing was done left over root twigs were removed and the samples was reduced to 1kg by quadratic method. Then the soil was packed in poly bag and sample number, sample location, area, farmer details, crop details, and date of sampling were noted on the bags and brought to the laboratory. In laboratory the soil samples were shade dried and crushed manually with the help of mallet and sieved through 2mm size sieve mash. About 500 g of soil sample was obtained after sieving and thus obtained soil sample was stored in a clean jute bag. The collected samples were analysed for Chemical, macro nutrients and micro nutrients parameters. The pH was determined by potentiometric method by making 1:2.5 soil water suspension where as EC was measured by digital EC meter. Organic carbon was determined by wet-oxidation method [6]. Available Nitrogen was determined by alkaline potassium permanganate method [7] by 800ml Kjeldhal flask. Phosphorous was determined by Colorimetric method by using spectrophotometer [8]. Available K was determined by Flame photometer using neutral ammonium acetate solution [9]. Exchangeable calcium and magnesium were estimated by Versanate titration method [10]. Available S was determined by using spectrophotometer [11]. Available micronutrients Fe, Cu, Zn, and Mn were determined by using DTPA extraction by using Atomic absorption spectrophotometer [12].

3. RESULTS AND DISCUSSIONS

The results of the chemical properties, macro and micronutrients of soil samples, from different villages of chaka block in Prayagraj district are given in Table: - 2.

The available Nitrogen content of soil samples range from 51 to 648 kg ha^{-1} with a mean value of 289.9, standard deviation of 184.7 and co-efficient of variation of 63.7% . Based on the limits suggested by Muhr et al. [13], out of total soil samples, 41.6% of the soil samples were in low nitrogen content, 45.8% of the samples were in medium range and 12.5% of the samples were in high range. Similar results were observed with Patel *et al., [14]*. Phosphorus content of soil samples were ranged from 6 to 48 kg ha^{-1} with a mean of 23.08, standard deviation of 11.47 and co-efficient of variation of 49.7%. out of total soil samples, 4.16% of the samples were in low phosphorus range, 62.5% of the samples were in medium range and 33.3% were in high range. Similar results were observed withYurembam *et al., [15]*. Potassium content of soil samples ranges from 78.4 to 392 kg ha^{-1} with a mean value of 144.6. Based on the limits suggested by Muhr *et al.[13]*, out of total soil samples, 66.6% of the samples were in low potassium range, the reason may be due to absence of elite rich potassium minerals in these soils, 29.1% of the soil samples were in medium range and 4.1% of the soil samples were in low potassium range. Similar results were observed with [16].

The exchangeable calcium content of soil samples ranges from 1.44 to 31.68 Meq/100g with a mean value of 8.49, standard deviation of 6.28 and co-efficient of variation of 73.98% . Based on the limits suggested by Ramamoorthy and Bajaj [17], out of total soil samples, 4.1% of the samples were in low range whereas 95.8% of the samples were in high range. Exchangeable magnesium content of soil samples ranges from 0 to 14.35 Meq/100g with a mean value of 4.77, standard deviation of 2.21 and co-efficient of variation of89.1% . Based on the limits suggested by Ramamoorthy and Bajaj, [17], out of total soil samples, 29.1% of the samples were in low range whereas 70.8% of the samples were in high range. Available sulphur content in soil samples ranges from 3 to 43 mg kg^{-1} with a mean value of 8.25, 9.34 as a standard deviation and 113.3% as co-efficient of variation. Based on the limits suggested by Awanish *et al*. (2014). Out of total soil samples, 83.3% of samples were in low sulphur content, 4.8% of samples were in

medium and 12.5% were in high range. Similar results were observed [18].

The content of zinc in soil sample were shown from 0.121 to 0.845 mg Kg^{-1} with a 0.394 as mean value, 0.175 as a standard deviation and 44.5% as a co-efficient of variation. Based on the limits suggested by Awanish *et al.*, (2014) for micro-nutrients. Out of total samples 91.6% of samples shown deficiency of zinc. The content of manganese in soil samples were shown 2.16 to 9. 75 mg Kg^{-1} with 4.553 as a mean value. The availability of iron has inverse relationship with pH *i.e.,* increase in pH causes reduction in availability of iron. Iron content in soil samples were shown 3.88 to 6.42 mg Kg^{-1} where 58.3% of soil samples are shown deficiency of iron and 41.6% are shown sufficient of iron. The pH and Organic matter are inversely relationship with availability of copper. The copper content in soil samples ranged from 0.25 to 1.32 mg Kg^{-1} with a 0.634 as a mean value. 66.6 % of soil samples shown excess content of copper in soil. Based on limits similar results by Awanish *et al*. (2014).

3.1 Soil Nutrient Index

In order to compare the levels of soil fertility of one area with those of another it was necessary to obtain a single value for each nutrient. The Organic carbon, Nitrogen, Phosphorus, Potassium, Sulphur, Zinc, Iron, Manganese and Copper Index calculated values are given in the Table:1. The nutrient index is calculated by using the formula as given by Muhr *et al*., [13]1963).

Nutrient Index (N.I.) = $\dfrac{NL \times 1 + NM \times 2 + NH \times 3}{NT}$

Where, NL: Indicates number of samples falling in low class of nutrient status

NM: Indicates number of samples falling in medium class of nutrient status

NH: Indicates number of samples falling in high class of nutrient status

NT: Indicates total number of samples analyzed for a given area.

The nutrient index value of less than 1.5 is rated as low, 1.5 to 2.5 is rated as medium and more than 2.5 is rated as high fertility status as suggested by Ramamoorthy and Bajaj [17].

3.2 Correlation Matrix between Physico-chemical Parameters of Soil in Chaka Block, Prayagraj, Uttar Pradesh

The data on correlation matrix between physico-chemical properties of soil of different villages in Chaka block of Prayagraj, Uttar Pradesh is given in Table:-3 .The bulk density of the soil in negatively non-significantly correlated with water holding capacity (r = -0.070), Phosphorus (r = -0.082), Iron (r = -0.169), copper (r = -0.043), negatively significantly correlated with organic carbon (r = -0.538), nitrogen (r = -0.546), sulphur (r = -0.390) and positively non-significantly correlated with particle density (r = 0.342), porosity (r = 0.001), pH(r = 0.366), EC (r = 0.166), potassium (r = 0.106), calcium (r = 0.037), magnesium (r = 0.379), zinc (r = 0.010), manganese (r = 0.172). The particle density of the soil is negatively non-significantly correlated with water holding capacity (r = -0.289), pH (r = -0.130), EC (r = -0.133), organic carbon (r = -0.317), nitrogen (r = -0.199), potassium (r = -0.360), calcium (r = -0.035), magnesium (r = -0.082), zinc (r = -0.095), manganese (r = -0.225) and positively non-significantly correlated with porosity (r = 0.942), phosphorus (r = 0.277), sulphur (r = 0.044), copper (r = 0.055).The porosity of the soil is positively significantly correlated with phosphorus (r = 0.259), positively non-significantly correlated with sulphur (r = 0.185), iron (r = 0.065), copper (r = 0.053) and negatively non-significantly correlated with water holding capacity (r = -0.302), pH (r = -0.252), EC (r = -0.219), organic carbon (r= -0.189), nitrogen (r = -0.036), potassium (r = -0.449), calcium (r = -0.046), magnesium (r = -0.214), zinc (r = -0.109), manganese (r = -0.281).The water holding capacity of the soil is positively non-significantly correlated with pH (r = 0.145), EC (r = 0.359), organic carbon (r = 0.304), nitrogen (r = 0.200), phosphorus (r = 0.176), potassium (r = 0.308), calcium (r = 0.216), manganese (r = 0.294) and negatively non-significantly correlated with magnesium (r = -0231), sulphur (r = -0.027), zinc (r = -0.023), iron (r = -0.137), copper (r = -0.078).The pH of the soil is negatively significantly correlated with potassium (r = -0.038), negatively non-significantly correlated with EC (r= -0.016), organic carbon (r = -0.207), nitrogen (r = -0.154), phosphorus (r = -0.436), sulphur (r = -0.190), zinc (r = -0.190), iron (r = -0.197), manganese (r = -0.081), copper (r = -0.241) and positively correlated with calcium (r = 0.037), magnesium (r = 0.034).The EC of the soil positively significantly correlated with manganese (r = 0.607), positively non-significantly correlated with phosphorus (r = 0.370), potassium (r = 0.797), calcium (r = 0.359), zinc (r = 0.271), iron (r = 0.254) and negatively non-significantly correlated with organic carbon (r = -0.030), nitrogen (r = -0.187), magnesium (r = -0.223), sulphur (r = -0.136), copper (r = -0.112). The

Table 1. Nutrient Index values of Chaka lock in Prayagraj district of Uttar Pradesh

Sl. No	Available nutrients	Nutrient index values	Category
1	Organic carbon	2.25	Medium
2	Nitrogen	1.708	Medium
3	Phosphorus	2.291	Medium
4	Potassium	1.375	Low
5	Sulphur	1.29	Low
6	Zinc	1.08	Low
7	Manganese	1.708	Medium
8	Iron	1.416	Low
9	Copper	2.66	High

Table 2. Soil quality parameters of different villages of Chaka block, Prayagraj, Uttar Pradesh

Sample No	Name of the Village	pH	EC (d S m^{-1})	OC (%)	N (Kg ha^1)	P (Kg ha^1)	K (Kg ha^1)	Ca (Kg ha^1)	Mg (Kg ha^1)	S (Kg ha^1)	Zn (Kg ha^1)	Mn (Kg ha^1)	Fe (Kg ha^1)	Cu (Kg ha^1)
S_1	Arail	7.51	0.20	0.81	381	17	156.8	08	0.4	03	0.528	3.432	4.618	0.928
S_2	Arail	7.47	0.21	0.41	165	27	179.2	10.2	0.6	03	0.536	9.756	4.623	0.536
S_3	Arail	7.33	0.31	0.72	406	48	257.6	13.8	0.2	08	0.667	7.532	6.291	0.864
S_4	Dewrakh	7.45	0.22	0.56	125	18	224.0	10.0	0.4	03	0.502	5.499	3.998	0.689
S_5	Dewrakh	7.72	0.24	0.48	178	25	392.0	12.0	2.6	03	0.542	5.784	4.014	0.815
S_6	Dewrakh	7.65	0.25	0.00	76	27	280.0	8.2	5.4	03	0.468	5.648	3.925	0.425
S_7	Mawaiya	7.65	0.16	0.31	114	21	89.6	06	7.4	03	0.568	6.421	4.825	0.625
S_8	Mawaiya	7.75	0.12	0.60	394	27	78.4	06	7.4	03	0.382	2.485	4.263	0.819
S_9	Mawaiya	7.60	0.12	0.50	292	17	100.8	7.2	1.2	03	0.562	2.814	3.888	0.935
S_{10}	Lawayan	7.80	0.15	0.85	584	17	100.8	7.6	02	03	0.344	3.485	4.349	0.523
S_{11}	Lawayan	7.31	0.14	0.50	483	17	112.0	7.8	1.4	03	0.326	2.165	3.897	1.215
S_{12}	Lawayan	7.40	0.13	0.50	305	13	89.6	8.2	1.6	03	0.374	2.356	4.023	1.325
S_{13}	Chat Kalana	8.33	0.19	0.10	51	06	89.6	9.8	00	03	0.253	3.145	4.125	0.425
S_{14}	Chat Kalana	7.60	0.17	0.52	318	17	112.0	9.4	02	03	0.253	4.685	4.325	0.254
S_{15}	Chat Kalana	7.54	0.15	0.02	51	13	100.8	7.8	1.8	13	0.845	4.263	6.425	0.567
S_{16}	Newada Samogar	7.44	0.17	0.60	330	13	156.8	3.8	06	8	0.164	2.841	3.984	0.426
S_{17}	Newada Samogar	7.53	0.15	0.02	51	13	89.6	17.8	02	8	0.274	4.625	4.265	0.615

Sample No	Name of the Village	pH	EC (d S m^{-1})	OC (%)	N (Kg ha^1)	P (Kg ha^1)	K (Kg ha^1)	Ca (Kg ha^1)	Mg (Kg ha^1)	S (Kg ha^1)	Zn (Kg ha^1)	Mn (Kg ha^1)	Fe (Kg ha^1)	Cu (Kg ha^1)
S$_{18}$	Newada Samogar	7.20	0.16	0.27	76	27	123.2	05	4.8	8	0.121	3.847	4.847	0.254
S$_{19}$	Madauka	7.50	0.18	0.70	305	48	123.2	8.8	1.4	8	0.384	2.425	4.328	0.321
S$_{20}$	Madauka	7.60	0.20	0.60	457	25	156.8	11.4	0.6	8	0.309	4.635	4.368	0.425
S$_{21}$	Madauka	7.61	0.19	0.17	203	13	134.4	8.6	0.8	25	0.145	5.847	5.289	0.569
S$_{22}$	Mahewa	7.25	0.17	0.52	343	48	89.6	7.6	2.8	20	0.263	3.941	4.789	0.859
S$_{23}$	Mahewa	7.55	0.17	0.89	622	25	112.0	7.2	3.8	10	0.248	6.245	6.235	0.452
S$_{24}$	Mahewa	7.52	0.14	0.91	648	32	123.2	8.2	03	43	0.413	4.925	3.987	0.369

Note: N=nitrogen, P=phosphorus, K=potassium, EC=electrical conductivity, OC=organic carbon, Ca=calcium, Mg=magnesium, S=sulphur ,Zn=Zinc, Cu=Copper, Fe=Iron, Mn=Manganese

Table 3. Correlation between Physico-chemical properties of soil in different villages of Chaka block

Parameters	Bd	Pd	Porosity	WHC	pH	EC	OC	N	P	K	Ca	Mg	S	Zn	Fe	Mn	Cu
Bd	1																
Pd	0.341	1															
Porosity	0.001	0.942***	1														
WHC	-0.070	-0.249	-0.302	1													
pH	0.366	-0.130	-0.252	0.145	1												
EC	0.166	-0.133	-0.219	0.359	-0.016	1											
OC	-0.538*	-0.317	-0.189	0.304	-0.207	-0.030	1										
N	-0.546	-0.199	-0.036	0.200	-0.154	-0.187	0.871	1									
P	-0.082	0.277	0.259	0.176	-0.436	0.370	0.379	0.276	1								
K	0.106	-0.360	-0.449	0.308	-0.038*	0.797	-0.002	-0.172	0.227	1							
Ca	0.037	-0.035	-0.046	0.216	0.037	0.359	-0.234	-0.222	0.041	0.255	1						
Mg	0.10	-0.082	-0.214	-0.231	0.034	-0.223	-0.159	-0.101	0.071	-0.021	-0.019	1					
S	0.037	0.044	0.185	-0.027	-0.190	-0.136	0.157	0.319	0.262	-0.154	-0.049	-0.038	1				
Zn	-0.390*	-0.095	-0.109	-0.023	-0.003	0.271	-0.037	-0.167	0.128	0.320	0.104	-0.081	-0.152	1			
Fe	0.010	0.008	0.065	-0.137	-0.197	0.254	-0.010	0.034	0.226	-0.059	0.041	-0.106	0.180	0.284	1		
Mn	0.172	-0.225	-0.281	0.294	-0.081	0.607*	-0.086	-0.163	0.226	0.459*	0.310	-0.009	0.093	0.300	0.415*	1	
Cu	-0.043	0.055	0.053	-0.078	-0.241	-0.112	0.102	0.122	-0.071	0.015	0.046	-0.153	-0.241	0.295	-0.109	-0.241	1

*Note: - (*) represents significant at 0.05 level, ** =   *** =*

organic carbon of the soil is negatively non-significantly correlated with potassium (r = -0.002), calcium (r = -0.234), magnesium (r = -0.159), zinc (r = -0.037), iron (r = -0.010), manganese (r = -0.086) and positively non-significantly correlated with nitrogen (r = 0.871), phosphorus (r = 0.379), sulphur (r = 0.157), copper (r = 0.102).

The macronutrients of the soil i.e., nitrogen status of the soil negatively non-significantly correlated with potassium (r = -0.172), calcium (r = -0.22), magnesium (r = -0.101), zinc (r = -0.167), manganese (r = -0.163) and positively non-significantly correlated with phosphorus (r = 0.276), sulphur (r = 0.319), iron (r = 0.034), copper (r = 0.122). Phosphorus of the soil negatively non-significantly correlated with copper (r = -0.071) and positively non-significantly correlated with potassium (r = 0.227), calcium (r = 0.041), magnesium (r = 0.071), sulphur (r = 0.262), zinc (r = 0.128), iron (r = 0.226), manganese (r = 0.226) and potassium of the soil positively significantly correlated with manganese (r = 0.459), positively non-significantly correlated with calcium (r = 0.255), zinc (r = 0.320), copper (r = 0.015) and negatively non-significantly correlated with manganese (r = -0.021), sulphur (r = -0.154), iron (r = -0.059).The secondary macro-nutrients i.e., calcium of the soil negatively non-significantly correlated with magnesium (r = -0.011), sulphur (r = -0.049) and positively non-significantly correlated with zinc (r = 0.104), iron (r = 0.041), manganese (r = 0.310), copper (r = 0.046), magnesium of the soil negatively non-significantly correlated with sulphur (r = -0.038), zinc (r =-0.081), iron (r = -0.106), manganese (r= -0.009), copper (r = -0.153) and sulphur of the soil positively non-significantly correlated with iron (r = 0.180), manganese (r = 0.093) and negatively non-significantly correlated with zinc (r = -0.152), copper (r = -0.241).

Micro-nutrients of the soil i.e., zinc of the soil is positively non-significantly correlated with iron (r = 0.284), manganese (r = 0.300), copper (r = 0.295). Iron of the soil is positively significantly correlated with manganese (r = 0.415) and negatively non-significantly correlated with copper (r = -0.109) and Manganese of the soil negatively non-significantly correlated with copper (r = -0.241).

4. CONCLUSION

The present investigation in chaka block, Prayagraj district, Uttar Pradesh clearly states

that soil is neutral to alkaline in condition. 100% of soil samples are in permissible limit of EC suitable for most of crops. 58.3% of the soil samples showed medium-high organic carbon content this is due to low and high temperature and less decomposition of organic matter in the soil. More than 50% soil samples are in medium range of nitrogen, phosphorus whereas potassium and sulphur are in low. Zinc, manganese and iron are in deficiency due to inverse relationship with pH *i.e.,* increase in pH causes reduction in availability whereas copper in sufficient range. According to the soil nutrient index potassium, sulphur, zinc and iron has showed low range of nutrient index whereas organic carbon, nitrogen, potassium and manganese are showed medium range. These analyses may help farmers to maintain proper nutrient management to obtain high yield with quality products. Still improvement can be done by improving cropping pattern, decomposition of organic waste, mulching and tillage practices.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/68378