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Assessment of soil fertility status in Jaunpur district of Uttar Pradesh

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Abstract
A study was conducted Khuthan Block of Jaunpur district of Uttar Pradesh of India. 70 Sample were collected from study area for evaluating physical properties bulk density, particle density and porosity, and chemical properties pH, EC, Organic carbon, soil macronutrient N, P, K and Sulphur. It can be concluded that, the soils were neutral to slight alkaline in reaction. All soils were observed low in organic carbon, available nitrogen and potassium, while available phosphorus was in medium category. Soils of slopy land were lower in fertility, compared to level agriculture land soils due to soil erosion and low nutrient retention capacity. It is suggested that farmer should follow soil test based fertilizer recommendation to get higher yield.

Keywords: Macronutrient, correlation, physico-chemical properties, Khuthan block

Introduction
Soil is the critical component of the earth system, functioning not only for the production of food, fodder and fiber but also in the maintenance of local, regional and global environmental quality. Soil is crucial for life on earth and is thus one of the most important natural resources. It is at the heart of terrestrial ecology, and an understanding of the soil system is a key to successful human use of the land and environmental harmony. Soil is the base of the life, which support all the living organisms of the earth. Plant depends upon the nutritional status of the soil for their growth and completion of the life cycle. Plants require at least 17 elements for normal growth and for completion of their life cycle. Those plant nutrients used in the largest amounts, carbon, hydrogen and oxygen, are Universal elements supplied by air and water. The other 14 elements are taken up by plants only in mineral from the soil or must be added as fertilizers. Plants need relatively large amounts of nitrogen, phosphorus, and potassium. These nutrients are referred to as primary nutrients, and are the ones most frequently supplied to plants by means of fertilizers. The three secondary elements *viz.*, calcium, magnesium, and sulfur, are required in smaller amounts than the primary nutrients. Calcium and magnesium are usually supplied with liming materials, and sulphur with fertilizer materials. Contaminants in rainfall also supply 10 to 20 pounds of nitrogen and sulphur per acre each year, depending on local air quality. The soils of Jaunpur district are sierozems, having alluvium deposited by rivers Gomati and Sai the rivers of Jaunpur. At many places, soils are intermixed with sandy material. These soils in general have high salt content and or high exchangeable sodium, particularly in areas of high water table having depressions. Their yellowish brown soils have loam to silty clay loam texture with massive structure and are calcareous in nature. The drainage conditions of soil ranges from good to moderate. The soils in eastern zone are mainly alluvial and prone to recurring floods and water logging. The calcareous nature of recent deposit has been observed in the soils. The soils are deep and sandy loam to loam in texture. Reference they show rather clear development of a structural profile.

Materials and Methods
Study area
The Jaunpur is a district place of state Uttar Pradesh. Geographical area of Jaunpur is 4038 km^2 (latitude 24` $24^0$ N to 26` 12^0 N and longitude 82` $70^0$ E to 83` 50^0 E). The district is bounded by Sultanpur to its North, Azamgarh to North-East, Ghazipur to East, Varanasi to its south east, Sant Kabir Nagar to the south, Allahabad to the south-west and Pratapgarh to the west The topography consists mainly of hilly and plateau lands but has lot of local variations too.

The soil of this region varies considerably but most of the area has red lateritic soils, experiences semi-arid and arid climate with an average annual minimum and maximum temperature 4 °C or 10°.

Climate

Jaunpur district has a climate consistent with that of the Northern Plain and Central Highlands including the Aravali range, hot semi-arid eco-region 4.3 °C and hot dry eco-region 9.2 °C. The temperature varies between about 4 °C (39 °F) and 10 °C (111 °F). The annual normal rainfall is 1,098 millimeters (43.2 in). The monsoon season occurs from the third week of June to the first week of October. Normally, there are 46 rain days per year of which 31 occur in the monsoon season. The district regularly suffers drought and pestilence.

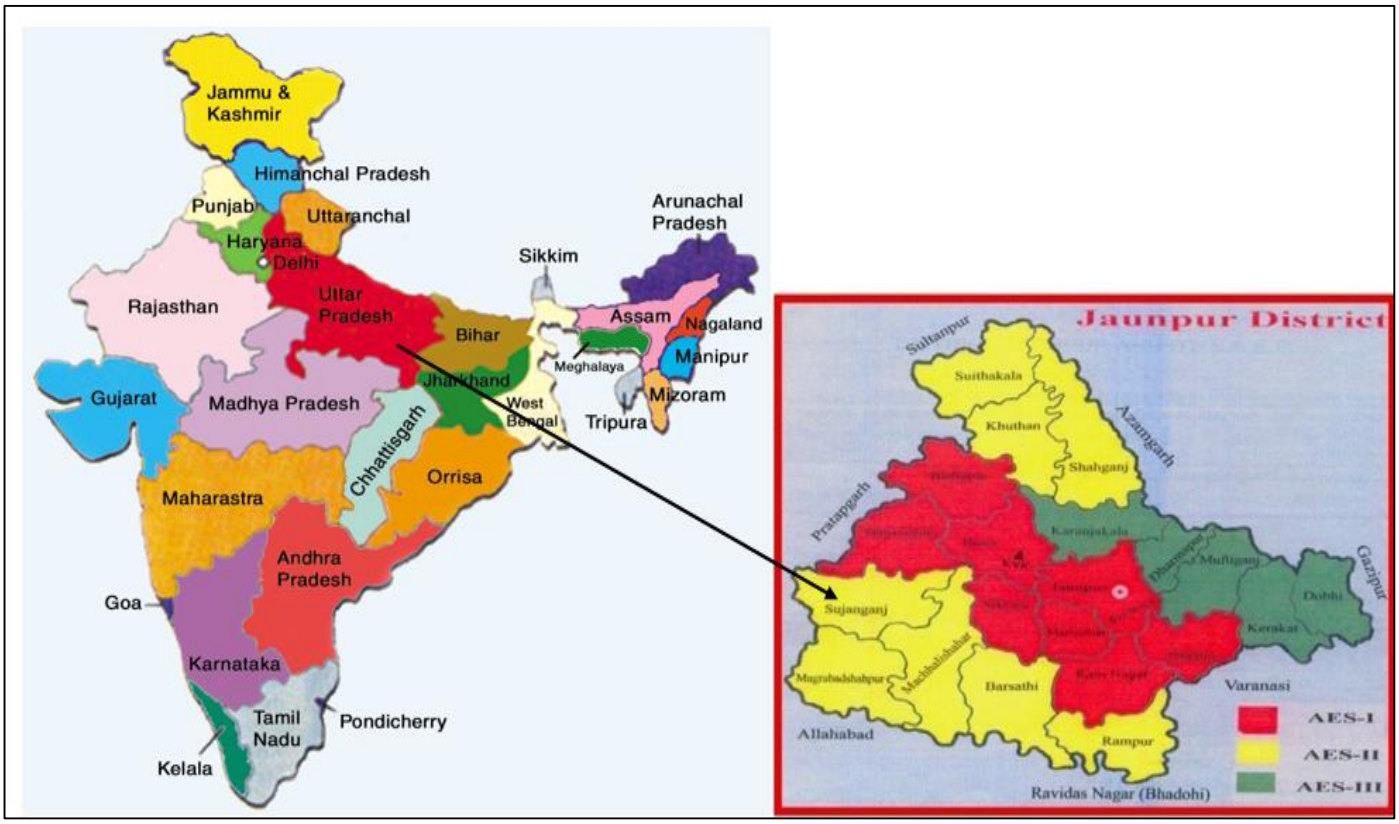

Fig 1: soil map of Jaunpur District

Soil sampling and analysis

Surface soil of the farmer's field from different villages of Khuthan block of Jaunpur district, were sampled randomly to a depth of 0-15 cm in V shape with the help of Khurpi. Each soil sample was mixed thoroughly and about a half kilogram of composite sample from farmer's fields was analyzed. The physical properties of soil viz. bulk density by core method, particle density by pycnometer method and porosity was measured following the procedure of Klute and Dirksen. Soil pH and electrical conductivity (EC) of the soil samples in soil: water suspension (1:2.5) was measured using a glass electrode in a digital pH meter and systronics electrical conductivity meter, respectively. Organic carbon was determined by wet digestion method of Walkley and Black, available Nitrogen by Alkaline permanganate method, Available Phosphorus by colorimetric method using sodium bicarbonate, Available Potassium by ammonium acetate extraction method, Available Sulphur by turbidimetric method.

Table 1: Location of soil samples collected from the Jaunpur District

Sample No	Cropping system		Irrigation
	Kharif	***Rabi***	
S_1	Maize, Till	Wheat, Barley	Channel, Submersible
S_2	Paddy, Maize	Wheat	Submersible
S_3	Maize, Bajra	Wheat	Submersible
S_4	Paddy	Wheat, Barley	Channel, Submersible
S_5	Maize, Guar	Wheat Mustard	Channel, Submersible
S_6	Cotton, Paddy	Wheat	Channel, Submersible
S_7	Cotton, Till, Guar	Mustard, Wheat	Channel, Tubewell
S_8	Cotton	Wheat	Channel, Tubewell
S_9	Till, Guar,	Mustard Pea	Channel, Tubewell
S_{10}	Cotton	Wheat	Channel, Submersible
S_{11}	Paddy	Wheat	Channel, Submersible
S_{12}	Cotton	Mustard, Wheat,	Channel, Tubewell
S_{13}	Guar, Bajra	Mustard, Chickpea	Channel, Tubewell
S_{14}	Guar	Mustard	Tubewell
S_{15}	Cotton	Mustard, Wheat	Channel, Tubewell

S_{16}	Till, Guar,	Mustard	Tubewell
S_{17}	Paddy, Cotton,	Wheat	Ghghar, Submersible
S_{18}	Cotton	Wheat Mustard	Channel, Submersible
S_{19}	Paddy	Wheat	Channel, Submersible
S_{20}	Jwar, Bajra,	Chickpea Mustard	Submersible
S_{21}	Paddy	Wheat, Chickpea	Channel, Tubewell
S_{22}	Arhar	Wheat, Chickpea	Channel
S_{23}	Paddy	Wheat, Chickpea	Channel
S_{24}	Vegetable	Wheat, Chickpea	Channel
S_{25}	Vegetable	Wheat, Chickpea	Channel
S_{26}	Arhar	Wheat, Chickpea	Channel
S_{27}	Maize	Mustard	Rainfed, Tubewell
S_{28}	Maize, Arhar,	Chickpea, Mustard,	Rainfed, Tubewell
S_{29}	Vegetabe	Tomato	Rain fed
S_{30}	Paddy, Maize,	Mustard	Channel, Tubewell
S_{31}	Arhar, Paddy,	Wheat, Mustard	Channel, Tubewell
S_{32}	Maize,	Wheat, Mustard, Potato	Rainfed, Tubewell
S_{33}	Maize, Arhar,	Mustard	Rain fed
S_{34}	Maize, Arhar,	Wheat Potato	Tubewell
S_{35}	Maize, Till,	Wheat, Mustard, Potato	Rainfed
S_{36}	Paddy, Maize, Arhar,	Mustard, Wheat	Rainfed
S_{37}	Paddy Maize	Wheat Potato	Channel, Tubewell
S_{38}	Paddy, Maize, Arhar	Wheat Potato	Channel, Tubewell
S_{39}	Paddy, Maize, Arhar	Chickpea, Mustard	Channel, Tubewell
S_{40}	Paddy, Maize, Arhar	ChickpeaMustard,	Channel, Tubewell
S_{41}	Paddy, Maize,Arhar	Chickpea Mustard	Channel, Tubewell
S_{42}	Paddy, Maize, Arhar	Mustard	Channel, Tubewell
S_{43}	Maize Arhar	Mustard	Submersible
S_{44}	Maize, Arhar	Mustard	Channel, Submersibile
S_{45}	Maize, Arhar	Mustard	Submersible
S_{46}	Maize, Arhar, Till	Wheat, Barley, Mustard	Channel, Tubewell
S_{47}	Paddy, Maize, Arhar	Mustard, Wheat	Channel, Tubewell
S_{48}	Paddy, Maize, Arhar	Wheat, Barley, Mustard	Channel, Tubewell
S_{49}	Maize, Arhar	Mustard	Tubewell
S_{50}	Maize, Arhar	Wheat, Mustard, Potato	Submersibile
S_{51}	Paddy	Wheat, Chickpea	Channel, Tubewell
S_{52}	Arhar	Wheat, Chickpea	Channel
S_{53}	Paddy	Wheat, Chickpea	Channel
S_{54}	Vegetabe	Wheat, Chickpea	Channel
S_{55}	Vegetabe	Wheat, Chickpea	Channel
S_{56}	Arhar	Wheat, Chickpea	Channel
S_{57}	Maize	Mustard	Rainfed, Tubewell
S_{58}	Maize, Arhar,	Chickpea, Mustard,	Rainfed, Tubewell
S_{59}	Vegetable	Tomato	Rain fed
S_{60}	Paddy, Maize,	Mustard	Channel, Tubewell
S_{61}	Arhar, Paddy,	Wheat, Mustard	Channel, Tubewell
S_{62}	Maize,	Wheat, Mustard, Potato	Rainfed, Tubewell
S_{63}	Maize, Arhar,	Mustard	Rain fed
S_{64}	Maize, Arhar,	Wheat Potato	Tubewell
S_{65}	Maize, Till,	Wheat, Mustard, Potato	Rainfed
S_{66}	Paddy, Maize, Arhar,	Mustard, Wheat	Rainfed
S_{67}	Paddy Maize	Wheat Potato	Channel, Tubewell
S_{68}	Paddy, Maize, Arhar	Wheat Potato	Channel, Tubewell
S_{69}	Arhar, Paddy,	Mustard	Rain fed
S_{70}	Maize,	Wheat Potato	Tubewell

Statistical Analysis

Observed data were statistically calculated for Pearson correlation coefficient between soil physico-chemical parameters of Jaunpur districts of Khuthan block by using SPSS-11.0 software statistical package. Pearson's correlation reflects the degree of linear relationship between two variables. It ranges from +1 to -1. A correlation of +1 means that there is a perfect positive linear relationship between variables. Standard deviation of different parameters ware also calculated by using SPSS-11.0 software statistical package

Results and Discussion

Physico-chemical properties of soil

Physico-chemical properties of Soil The data on pH, EC, B.D., P.D. and organic carbon are presented in Table 2 and 3**.**The bulk density of Khuthan block has been presented in Table No 1**.** The bulk density of the collected soil samples of Jaunpur district ranged between 1.27 to 1.39 Mg m^{-3} with the mean value of 1.44 Mg m^{-3} and standard deviation ±0.40. However, bulk density observed in most of the soils of district was medium to high. The soils were collected from cultivated areas. Thus, due to continuous tillage operation in rice, wheat, pulse and vegetables producing and low accumulation of

organic matter resulted in high to medium range of bulk density, similarly found as (Kumar and Babel).

Particle density of different cultivated soils of Jaunpur district varied from 2.46-2.75 Mg m^{-3}, with the mean value of 2.38 Mg m^{-3} and standard deviation was ± 0.21, presented Table No 2. Highest particle density was observed 2.75 mg m^{-3} in the soils of Ramdular prajapati followed by 2.60, 2.57 and 2.53 Mg m^{-3} in the soil samples of Chack 2MJD, Chack 6BHM and Ghahdu, respectively. However, lowest value was observed in the soil samples of 1.96, 1.98 and 2.10 Mg m^{-3} in the soils of Bilochawali, Nagrana and Chack 3LBM, respectively. Highest particle density in the soils of Jaunpur was observed from Emampur and lowest from Tikarikhurd. Comparatively lower average value of particle density in the cultivated soils of Jaunpur district, Similarly found as (Kumar and Babel, Singh *et al*).

Soil reaction of the Jaunpur soil varied from 7.1 to 8.5 with the mean value of 7.79, SD 0.38 presented in Table No 2. Considering the wide variation in soil reaction under different cropping pattern were neutral to alkaline in nature. Majority of soils were slightly alkaline (70%) and rest was neutral in nature. The maximum pH was observed Dablirathan (pH 8.5), followed by Chack 7GGR (pH 8.4) and Chack 2MJD (pH 8.3) and minimum was Chack 25STG and Chack 3STG (pH 7.1). However, the soils of Khuthan block of Jaunpur district were slightly acidic to light alkali and soil reaction was ranged between 7.2 to 8.5 pH. Among the 50 soil samples of the Jaunpur district, 16.7% soil was neutral in reaction (pH ranges 7.2 to 7.5) and 66.7% soil sample was slightly alkaline in nature. The cropping systems in these locations are generally rice-wheat, pulse, sugarcane, vegetable, fruits and forage crop. This indicates that the cropping system have not significant effect on buffering capacity of the highly fertile soils of Jaunpur district of khuthan block. Similarly found as (Kumar and Babel, Nigam *et al.* Singh *et al.*)

Electrical conductivity in surface soil was highest in rice field soil of Tandurwali (2.10 dS m^{-1}) and lowest in Guwar-Mustard cropping system area of Chack 7GGR (0.20 dS m^{-1}). In Jaunpur district the electrical conductivity was highest in soils of vegetable field of Deva (1.20 dS/m^{-1}) and lowest in Arhar-Mustard cropping system area of Baghmandwa (0.10 dS/m^{-1}). Since, EC value of soil less than 4 dS/m^{-1} is not so serious salt accumulation problem, the EC values of all the soils in different cropping system of the districts were comparatively of low to medium. Similarly found as (Kumar and Babel, Nigam *et al.* Singh *et al.*)

Organic matter content in cereal, sugarcane, pulse, vegetable, fruit and fodder cultivated soils of Khuthan block of Jaunpur district varied from 1.005 to 1.43%. In soils comparatively the content of organic matter was higher in Dablirathan due to incessant renewal through plant and animal residues in this soil. The organic matter content was lowest in Chack25 STG soil in Rice and Vegetable growing area. In Jaunpur district, the highest organic matter content was obtained in soil of Dhammaur lowest was noticed in Nauli, Similarly found as (Kumar and Babel, Nigam *et al.* Singh *et al.*)

Available nutrient N, P K and S status of khuthan block of jaunpur

Available nitrogen of the farmer's field exhibited low range and varies from 186 to 269 kg ha^{-1} with an average content of 255.6 ±28.03 kg ha^{-1} (Table No 3) in soils of Jaunpur district. Soil fertility status of available nitrogen is categorized on the basis as followed: low (< 270 kg ha^{-1} N), medium (272-560 kg ha^{-1} N) and high (> 560 kg ha^{-1} N). Results revealed that Jaunpur districts soil samples were found in the low category in soil in available nitrogen content in soils. None of the sample was found in the high content of available nitrogen in these farmer's field soils of the districts. Continuous crop removal and leaching loss of nitrate contributes towards low nitrogen content in these farmers' field achieving higher crop productivity. However, Khuthan soil was somewhat batter condition due to presence of organic matter and also cropping intensity is lower than districts soil is undulate plateau and hills due to which moisture scarcity during most of the periods in the year remains dry in condition and is limit the crop removal of nitrogen. Kumar *et al*. (2009) [10] reported that available N content of Dhumka and Lakhimpur series varied from 125 to 310 kg ha^{-1} with a mean of 216 kg ha^{-1}.

The available phosphorus content of the farmer's field (Table 3) of Khuthan block soils ranges between 23.5 to 50.3 kg ha^{-1} with an average content of 39.59±9.01 kg ha^{-1} and Jaunpur districts between 25.6 to 60.1 kg ha^{-1} with an average content of 45.27±9.55 kg ha^{-1}. The data clearly showed that the available phosphorus of the districts was higher in range. Its content in the soils is categorized in to different phosphorus fertility status as: low (< 10 kg ha^{-1} P), medium (10-20 kg ha^{-1} P) and high (> 20 kg ha^{-1} P).This observation suggests that farmers are using continuously phosphatic fertilizer in their field for cultivating crops without testing the soils. High level of phosphorus in the soils indicated P build up with added water soluble phosphatic fertilizers. Phosphorus availability is not a problem because of having neutral soil reaction Mandal and Chatterjee (1972) [11].

The data on available potassium content in the soils of farmer's field of the Khuthan were presented in the Table 3, respectively. Overall, an assessment of the soil samples revealed that Jaunpur district soils of the farmer's field ranged from 325 to 489 kg ha^{-1} with an average content of 355.9±32.64 kg ha^{-1}. The soils of the district exhibit availability medium to high potassium status in these soils may probably be due to presence of K bearing clay minerals. Based on soil testing K rating, sample is categorized in to low (< 108 kg ha^{-1}), medium (108-208 kg ha^{-1}) and high (> 208 kg ha^{-1}). Singh and Singh (2003) were also reported that the soil of the experimental field of Rajasthan was clay loam with mean values of available potassium 277 kg ha^{-1}. Basumatary and Bordoloi (1992) [2] studied the forms of potassium in some soils of Assam in relation to soil properties. They reported that the total K content of the soils varied widely on an average value of 371.2 (Cmol P^{+}) kg^{-1}.

The data on available sulphur in the soils of Jaunpur district were presented in the Table 3, respectively. In the soils of Khuthan block, the available sulphur varied from 13.3 to 27.8 kg ha^{-1} with an average content of 21.79 ± 4.57 kg ha^{-1}. Maximum value was obtained from village Tighara and lowest in Nauli. In the soils of Khuthan block, the available sulphur range in soil varied from 16.3 to 28.7 kg $ha^{-1}$with an average content of 21.90± 3.61 kg ha^{-1}.The maximum value was noticed from Emampur and lowest in Nauli. The available sulphur in the soils of districts was ranged between low to medium may be due to low organic carbon similarly found as Basumatary and Bordoloi (1992) [2]

Table 2: Physico- chemical properties of the soil of Khuthan block of Jaunpur District

S.N.	Statistical parameter	Physico-chemical parameter				
		B.D Mg m^{-3}	P.D Mg m^{-3}	pH	EC (dS m^{1})	Organic Matter
1	Mean	1.44	2.38	7.79	0.62	0.45
2	Maximum	1.39	2.75	8.5	2.10	1.43
3	Minimum	1.27	2.46	7.2	0.20	1.005
4	S.D.	0.40	0.21	0.38	0.19	0.12

Table 3: Available nutrient content in soils samples of Khuthan block of Jaunpur District.

S. n	Statistical parameter	Available nutrient			
		N Kg/ha	P Kg/ha	K Kg/ha	S
1	Mean	255.6	39.59	355.9	21.79
2	Maximum	269	50.3	489	27.8
3	Minimum	186	23.5	325	13.3
4	S.D.	28.03	9.01	32.64	4.57

Correlation between Physico-chemical Properties of the Soils

Coefficient of correlation of relevant soil properties of Jaunpur districts (Table 1 and 2) such as bulk density, particle density, pH, EC organic carbon, available major nutrient (N, P, K and S) are presented in Table 1and 2. The pH of soils of Jaunpur districts were positively correlated with organic matter. Available phosphorus was positively correlated with pH, organic carbon in the soils of Jaunpur. Available sulphur content in the soils was positively correlated with pH, organic carbon, No any significant relationship was observed between available nitrogen and potassium content in the soils of the districts. Results were also reported by Akbari *et al.* (2008) and stated that the available nutrient content was negatively related with pH and positively with organic corbon content of soil. Organic carbon played the most important role for variation in available phosphorus. No significant relationship was observed of the surface soil properties studies from Khuthan block region of Jaunpur

Table 4: Correlation study between physic-chemical properties of Khuthan block of Jaunpur district soils.

	BD	PD	pH	EC	OC	N	P	K	S
BD	1								
PD	0.336	1							
pH	0.168	0.238	1						
EC	0.256	0.107	0.091	1					
OC	0.015	0.201	0.784**	-0.101	1				
N	0.303	-0.128	0.132	-0.273	0.181	1			
P	0.247	0.274	0.582**	-0.081	0.872**	0.252	1		
K	0.014	-0.079	-0.009	-0.442	0.041	0.320	0.109	1	
S	0.296	0.313	0.707**	-0.089	0.852**	0.290	0.935**	0.102	1

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Conclusions

It can be concluded that the No any significant relationship was observed between available nitrogen and potassium content in the soils of the district. However, available phosphorus and sulphur was positively correlated with pH, organic carbon, caitions exchange capacity and $CaCO_3$ in the soils of Khuthan block Based on the results summarized above, it is concluded that the soil fertility status of the district was not upto the optimum level. The multi nutrient deficiency especially N, P, K and S were recorded. The deficiency of these nutrients was due to poor physico-chemical condition of the soils. To improve the soil condition of the Jaunpur district of Khuthan block, integrated nutrient management approach and as possible, maximum use of organic sources of nutrient during crop production is recommended.

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