Original Research Article

Study of Soil Fertility status in KVK farm, Shahjahanpur, Uttar Pradesh, India

Abstract

A study entitled Study of soil fertility status in KVK farm Shahjahanpur, Uttar Pradesh, India was carried out during 2020-21. Soil Samples collected from different depths viz. 0-15 (Surface), 15-30 cm (Subsurface) were processed and analyzed for chemical properties. Soil pH, EC and OC ranged from 8.13-8.73, 0.20-0.28 and 0.41-0.76 at surface and all the samplers belongs to moderately alkaline to strongly alkaline range. Soils of KVK, Shahjahanpur classified based on pH, EC (1:2.5 soil: water ratio), and OC were low to medium, majority of soils falls under low EC and low to medium organic carbon, the available nitrogen of samples was in the range of 201.19 to 287.84 kg $ha^{-1}$and were in low nutrient index range (1.38 NI), the available phosphorus of samples range between 16.34 to 21.67 kg $ha^{-1}$for and falls in medium nutrient index range (2NI) while the available potassium of samples range between 357.54 to 484.98 kg ha^{-1} and falls in high nutrient index range (2.67 NI) where correlation acted positive in many of the cases. The soils of KVK, Shahjahanpur were categorized into low-medium-high (LMH) category based on available N, P and K concentrations. Ca/Mg ratio of the study area varied from 1.99-2.01 while Mg/K ratio varied from 1.20 to 2.26. Soils of study area were found in sufficient range for available Cu, Zn and Mn except of (Fe) Iron range found in marginal to sufficient. In these range of available nutrients wheat, rice, maize, fodder crops, pulses and some vegetables can be grown very well.

Keywords: *fertility status, available N, Chemical properties, Nutrient availability*

Introduction

In India, the productive resource base of the country is seriously impaired by major soils that display persistent degradation. The soil is one of the most important natural resources for plant growth, that deteriorates from its original status due to the imbalance fertilizer usages, faulty management practices, incorrect crop rotation, excess irrigation and adverse climate conditions, thereby decreasing development and productivity simultaneously the productivity of wheat, rice, mustard, maize and sugarcane, is low. Productivity is decreased by imbalance and insufficient nutrient supply due to excessive salinity and alkalinity, EC, low organic carbon, low or very poor hydraulic conductivity and poor to very poor infiltration. The presence of more salt in the rooting zone may have a germination effect or may be essential for crop development.

Maintaining soil fertility is a key problem in Indian agriculture, especially given the country's rapidly growing population in recent decades. Continuous cultivation with imbalance of fertilizer usage and increase nutrient exhaustive crops or irregular rainfall patterns, minimal recycling of dung and crop residues to the soil are the causes of soil degradation in India. The country's primary problems are restoring natural resource status, boosting agricultural productivity, decreasing poverty, and attaining food security. As a result, all effort should be directed at preserving the physical, biological, and socioeconomic environment through the growth of food crops, livestock, wood, and other goods through the sustainable use of ecosystems. Soil organic matter affects soil fertility in a variety of ways, including affecting physical and chemical characteristics, functioning as a source of mineralizable carbon and nitrogen, and protecting the soil from erosion; it also regulates soil microbial activity. Due to mineralization and leaching of dissolved organic matter, a balance occurs in mature and undisturbed tropical ecosystem between the input and production of the soil organic carbon (Zech *et al.*, 1997). Plant nutrition, which stresses the shape and availability of soil nutrients, their transport to the root's end point of absorption, and the utilization of plant nutrients, is intimately connected to soil fertility (Foth and Ellis, 1997). Soil fertility is the soils ability to provide sufficient quantities of nutrients in balance and available form without causing toxicity, while soil productivity is the soil's ability to generate a particular crop or crop series with specific management method. Any cropping system’s optimum productivity depends on adequate plant nutrient supply, if the soil is unable to supply the necessary nutrients for normal plant development and optimum productivity, it is necessary to apply supplemental nutrients. The quantity of fertilizer supplementation is determined by information about the crop's nutritional demand and the soil's nutrient providing capabilities. The soil’s buffering ability for fertility depends on the degree of nutrient saturation at the exchange site, the form of clay, the amount of organic matter and the complementary effect of ions (Foth and Ellis, 1997). Continuous nutrient withdrawal combined with little to no replenishment has increased the risk of future nutrient-related plant stress and yield loss. Because soil fertility is one of the factors of soil productivity, it is important to analysis the fertility status of a soil in order to estimate its productivity. Nowadays, cultivated land is being shifted to the real state due to rising population pressure and urbanization In addition, the shortage of land for food crop production leads to higher crop intensity and the practices is rare. The shortage of grassland (grazing areas) has forced farmers to use residues of crop for animal feed. For the conservation of soil fertility and productivity, cow dung is used primarily for firewood rather than as manure. The "optimal" soil pH is close to neutral. Neutral soils have a pH of 6.5 to 7.5, which is mildly acidic to slightly alkaline. Many plant nutrients have been shown to be most available to plants when the pH is between 6.5 and 7.5.This pH range is typically favorable for plant root development.

Materials and Methods

Study area

A study entitled Study of soil fertility status in KVK farm Shahjahanpur, Uttar Pradesh, Indi, was carried out during 2020-21. Soil Samples was primarily focused on testing of soil quality of 18 representative samples (numbered as 1 to 18) and the analytical results were supposed to represent the entire field. The surface contaminated soil material were removed using spade or khurpi collected from different depths viz. 0- 15, 15-30 cm were processed and analyzed chemical properties. The soil samples were collected from the KVK, of Shahjahanpur

(U.P.) which is located at latitude of 27^0 52′ 45.590″ N and longitude of 79^0 55′ 11.574″ E east and at an altitude of 144 Mt above mean sea level (MSL). Shahjahanpur has Mid-Western Plain Zone and Uttar Pradesh has semi-arid to sub-tropical climate.

Collection, processing and determination methods soil samples

The present study deals with the analysis of soil samples from KVK, field of Shahjahanpur. Soil samples were collected during the period of 2019- 2020. This study was primarily focused on testing of soil quality of 18 representative samples (numbered as 1 to 18) and the analytical results were supposed to represent the entire field. The surface contaminated soil material were removed using spade or khurpi (Gupta, 2007) and use soil sampling augur for collecting a uniform representative sample from two depth i.e. 0-15cm and 15-30 cm. The collected soil samples were air dried after grinding with wooden pestle and mortar, then sieved through 2-mm sieve, labeled and stored. The samples were analyzed by appropriate method for chemical parameters *viz.* pH by pH meter, electrical conductivity (EC) by solu-bridge method (Jackson 1973), organic carbon (OC) by method of Walkley and Black (1934), available nitrogen (N) using method described by Subbiah and Asija (1956), phosphorus (P) using method of Olsen *et al*. (1954), available potassium (K) by method of Hanway and Heidal, (1952), available zinc (Zn), iron (Fe), copper (Cu) and manganese (Mn) using DTPA extractant method proposed by Lindsay and Norvell (1978). The analytical results of each soil sample was categorized as low, medium and high categories for OC and macronutrients and as deficient, moderate and sufficient for micronutrient based on standard rating values.

Nutrient index value and fertility rating

Nutrient index value (NIV) was calculated from the number or proportion of samples under low, medium and high available nutrient status (Meena *et al*., 2006)

$$\text{Nutrient Index} = \frac{(1\text{x no. of sample in low category}) + (2\text{x no. of sample of medium category}) + (3\text{x no. of sample in high category})}{\text{Total number of sample}}$$

The index values are rated into various fertility categories *viz*., low (<1.67), medium (1.67-2.33) and high (>2.33) for available N, P and K.

Correlation Study

The correlation coefficient, r is known as Pearson's Correlation coefficient, since it was developed by Karl Pearson will be computed as follows:

$$\text{Correlation coefficient}\,(X,Y) = \frac{\sum\left(x - \bar{x}\right)\left(y - \bar{y}\right)}{\sqrt{\sum\left(x - \bar{x}\right)^2 \sum\left(y - \bar{y}\right)^2}}$$

r = correlation coefficient

x = value of the x-variable in a sample

$\bar{x}$ = mean of the values of the x- variable y = value of the y- variable in a sample

$\bar{y}$ = mean of the values of the y- variable

Result and Discussion

Soil reaction (P^H)

Soil reaction of the study varied from 8.13 to 8.73 in a very narrow range with mean value of 8.25 and out of all 18 samples 77.77% were found within moderately alkaline, and rest 22.22% fall under strongly alkaline reaction category (Table. 1). The relative high pH of the soils might due to the presence of high degree of base saturation (Vijay *et al.,*2011)

Electrical conductivity (EC)

The electrical conductivity of the soil water suspension ranges from 0.20 to 0.28 dSm^{-1} in soil of study area with a mean value of 0.24 dSm^{-1} (Table. 1). All the collected soil samples fall under low EC (0.15-0.50 dSm^{-1}) category. It indicated that there is no soil limitation for crop production from soluble salt concentration in soil (Vijay *et al.,*2011).

Organic carbon (OC)

Organic carbon content in study area ranges from 0.41 to 0.76% with a mean value of 0.58%. From all collected soil samples 33.33% samples fall under low, 61.11%under medium and rest 5.56% under high fertility category (Table. 1). It may be ascribed due to the fact that soils have very low carbon pool and high C decomposition due to warm climate (Jatav *et al.*, 2012). It can be increased by applying organic matter in field and mulching of field by straw which may ultimately help in improving soil fertility.

Available nitrogen (N)

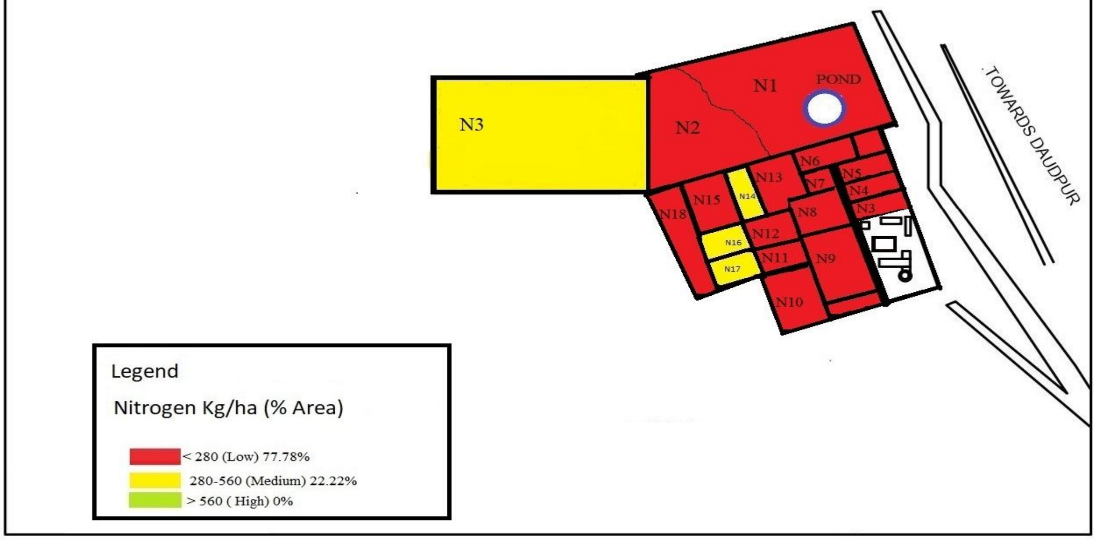
Available N content in soil of study area ranges from 201.19 to 287.84 kg ha^{-1} with mean value of 244.51 kg $ha^{-1}$and out of all 18 samples 77.78% were found in low, and rest 22.22% fall under medium fertility category (Table. 1) and (Fig. 1). Nitrogen is a main component of crop to maintain level of nitrogen in soil leguminous crops can be taken in crop rotation which helps in fixing nitrogen and ultimately maintaining the status of soil. It may be ascribed to the poor organic carbon pool of soil (Jatav *et al.* 2012).

Available phosphorus (P)

Available P content in KVK farm of Shahjahanpur found to be varied from 18.78 to 24.89 kg ha^{-1} with average content of 21.83 kg ha^{-1} with 100% collected soil samples representing medium fertility status (Table. 1) and (Fig. 2). It might be due to poor C pool and fixation by montmorillonitic clay of the soil in the region (Singh *et al.* 2017).

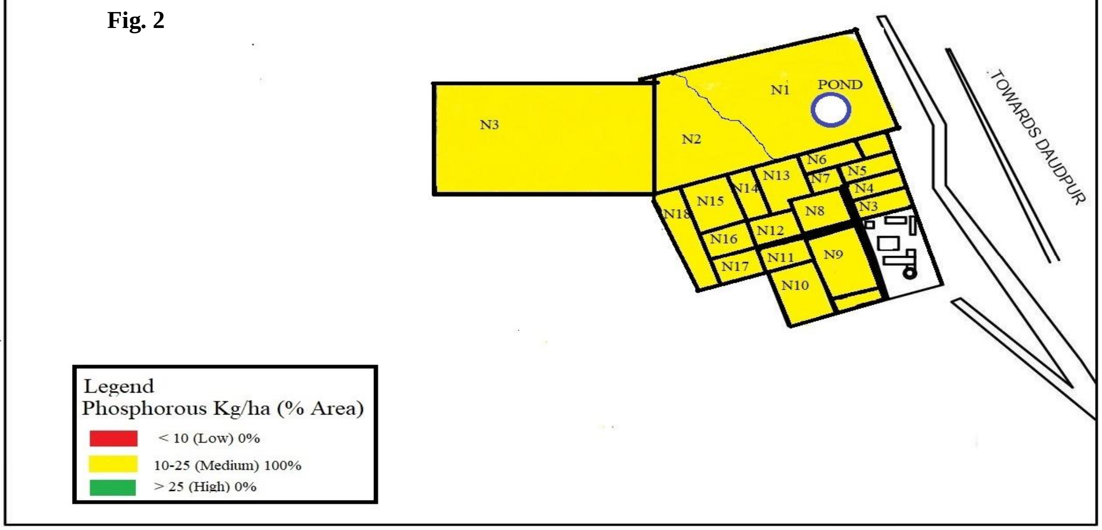
Fig. 1

Status of N in the soil of KVK, Shahjahanpur



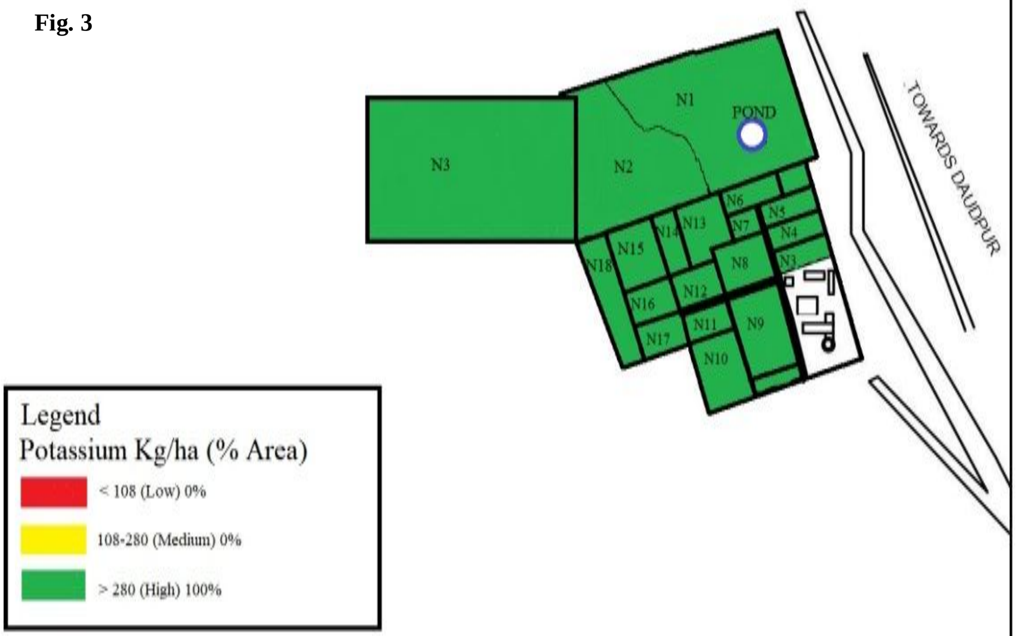
Status of P in the soil of KVK, Shahjahanpur

Fig. 2



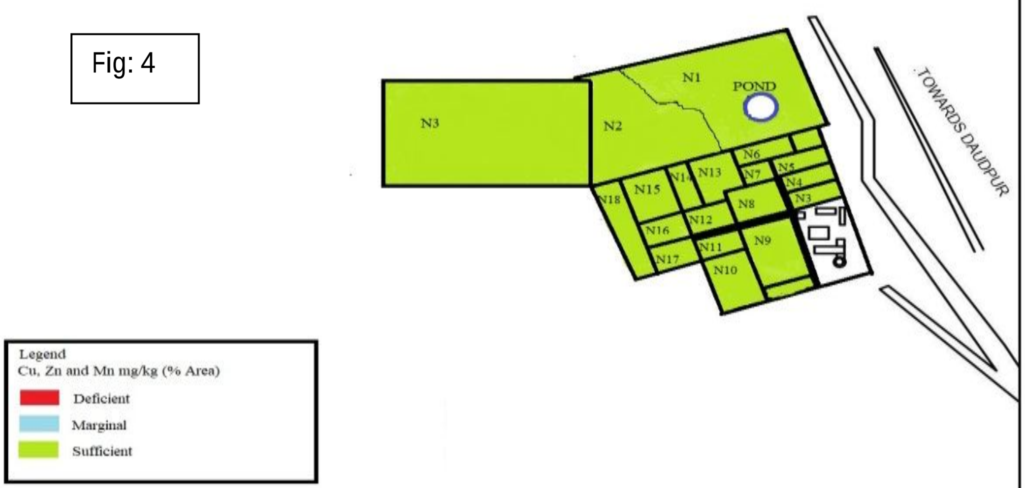
us of K in the soil of KVK, Shahjanpur

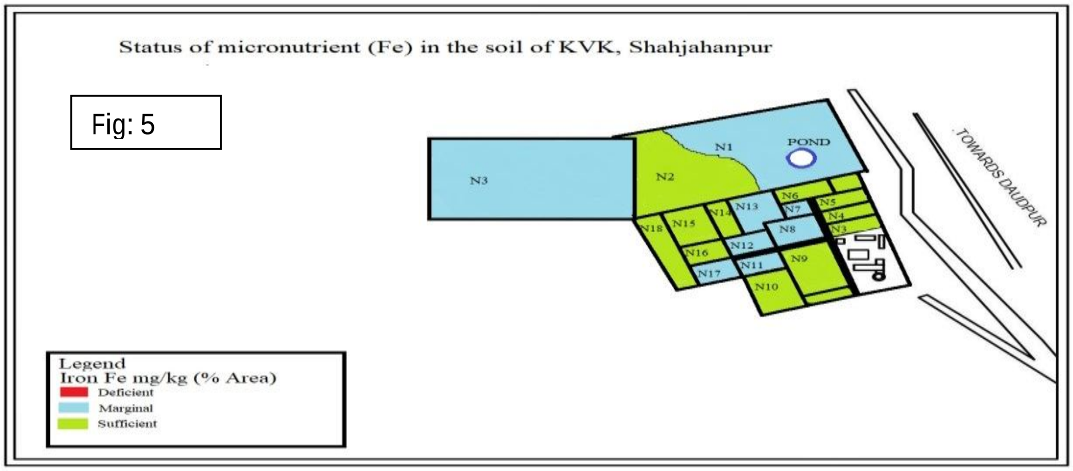
Fig. 3



Status of micronutrients (Cu, Zn and Mn) in the soil of KVK, Shahjahanpur

Fig: 4





Available potassium (K)

Soil available K status ranges from 357.54 to 484.98 kg ha^{-1} with mean value of 421.26 kg ha^{-1}. All soil samples fall under high fertility categories (Table.1) and (Fig. 3) indicating there is no K deficient area within the study area.

DTPA extractable micronutrients

Available Fe content in the study area found to be ranging from 6.66 to 14.17 mg kg^{-1} with mean value of 20.83 mg kg^{-1}. Of all collected samples 44.44% samples were found in marginal and 55.55% in sufficient fertility category (Table. 1) and (Fig. 5).

Available Mn content in all soil samples were in sufficient category with its content found to be within 14.53 to 24.53 mg kg^{-1} with a mean value of 19.53 mg kg^{-1} of soil (Fig. 4) in the study area.

Available Cu content in study area found to be ranges from 0.57 to 1.93 mg kg^{-1} with a mean value of 1.25 mg kg^{-1}. All the collected soil samples fall under sufficient categories (Table. 1) and (Fig. 4).

Available Zn content in study area found to be ranges from 2.66 to1.25 mg kg^{-1} with a mean value of 1.95 mg kg^{-1}. All the collected soil samples fall under sufficient categories (Table. 1) and (Fig.4).

Correlation among chemical properties

In Table -2 soil pH was correlated significantly and negatively with electrical conductivity (r=-0.373), organic carbon (r=- 0.757), Copper r=(-0.068), Mn (r=-0.494) and negatively with Phosphorus (r= -0.103) potassium (r= -0.038), Relationship study between EC and other properties shows that significant positive correlations exist between EC and N(r=0.244), K(r=0.215), Fe(r=0.096), Zn(r=0.253) and Mn (r=0.490) while a positive relation with properties like P (r=0.253), OC (r=0.286), SAR (r=0.234) and ESP(r=0.237) was observed. Relationship among the nitrogen and other chemical properties ware also workout and data shows that nitrogen was positively strongly significantly correlated with OC (r=0.956), Significant positive correlation was also found with Cu (r=0.095), Fe (r=0.185) and Zn (r=159) but could not reaches to level of significance Relationship of Phosphorus with chemical properties positive correlation existed between phosphorus and potassium (r=0.273), OC (r=0.419) while copper, iron, Mn and zinc ware correlated with phosphorus positively and non-significantly. A negative relationship found between P and SAR (r=-0.169) and ESP (r=-0.307). Potassium was found to related with copper (r=0.190), Mn (r=0.229) positively and non-significantly while organic carbon, SAR and ESP was related positively. a negative correlation was established with Zn (r=-0.228) and Fe (r=-0.225) but could not reach to the level of significance Organic carbon was positively and non-significantly correlated with Fe (r=0.431), while positive correlation was established of organic carbon with copper (r=0.389, Zinc (r=0.239) and Manganese (r=0.234) organic carbon was negative correlated with SAR and ESP. Strong positive correlation of copper with Fe (r=0.302), Mn (r=0.0.14) Zn(r=0.264) ware found. Copper was positively correlated to SAR (r=0.136) and ESP (r=0.135) but not to level of significance. Iron was positively and correlated with Mn (r=0.334) Zinc (r=0.343) and negatively with SAR (r=-0.368) and ESP (r=-0.369). Manganese was strongly and positively correlated with Zinc(r=0.232) and positively with SAR (r=0.011) and ESP (r=0.009). Zinc was negatively correlated with SAR and ESP while SAR was strongly and positively correlated with ESP (r=0.998).Similar result was also obtained by (Vijayakumar *et al.* 2011) (Singh *et al*. 2017).

Nutrient management & fertilizer recommendation

Based on the result obtained from this study and fertility maps prepared based on it better nutrient management practices taken up to avoid imbalance fertilizer application and improve crop production.

As KVK farm is an extensive area where a lot of crop plants are cultivated based on their nutrient requirement proper input should be provided. For crop plants, in the deficient, sufficient and high fertility area of a particular nutrient 25% more than recommended, exact recommended and 25% less than recommended dose of fertilizer respectively should be provided. But for fruit and plantation crop nutrient uptake should be correlated with soil nutrient and accordingly nutrient should be applied to soil of the area.

Table 1: Soil Fertility Status of KVK Farm, Shahjahanpur Uttar Pradesh

S. No.	Soil Characteristics	Range	Average	% Sample Category			NIV	Fertility
				Low	Medium	High		
1	pH	8.13 - 8.73	8.43	-	-	-		-
2	EC (dSm^{-1})	0.20 - 0.28	0.24	-	-	-		-
3	OC (%)	0.41 - 0.76	0.58	33.33	61.11	5.56	1.27	Low
4	N ($kg\ ha^{-1}$)	201.19 -287.84	244.51	77.78	22.22	0.00	1.22	Low
5	P ($kg\ ha^{-1}$)	18.78 - 24.89	21.83	0.00	100	0.00	2.00	Medium
6	K ($kg\ ha^{-1}$)	357.54 - 484.98	421.26	0.00	0.00	100	3.00	High
7	Cu ($mg\ kg^{-1}$)	0.56 - 1.93	1.24	0.00	0.00	100	3.00	High
8	Mn ($mg\ kg^{-1}$)	14.53 - 24.53	19.53	0.00	0.00	100	3.00	High
9	Zn ($mg\ kg^{-1}$)	1.25 - 2.66	1.95	0.00	0.00	100	3.00	High
10	Fe ($mg\ kg^{-1}$)	6.66 - 14.17	10.41	0.00	44.44	55.55	2.50	High

Table-2 Correlation among different chemical properties of Shahjahanpur KVK soil

Parameter	pH	EC	N	P	K	OC	Cu	Fe	Mn	Zn	SAR	ESP
pH	1.000											
EC	-0.373	1.000										
N	0.089	0.244	1.000									
P	-0.103	0.253	0.468	1.000								
K	-0.038	0.215	0.152	0.273	1.000							
OC	-0.010	0.286	0.956	0.419	0.320	1.000						
Cu	-0.068	-0.202	0.095	0.163	0.190	0.098	1.000					
Fe	0.288	0.096	0.185	0.121	-0.225	0.001	-0.302	1.000				
Mn	-0.494	0.490	0.080	0.233	0.229	0.234	0.014	-0.334	1.000			
Zn	0.025	0.253	0.159	0.079	-0.228	0.039	-0.264	0.349	-0.232	1.000		
SAR	0.234	0.071	-0.306	-0.169	0.438	-0.135	0.136	-0.368	0.011	-0.091	1.000	
ESP	0.237	0.067	-0307	-0.171	0.436	-0.137	0.135	-0.369	0.009	-0.093	0.998	1.000

Conclusions

From the above intensive study of the KVK farm Shahjahanpur, Uttar Pradesh, it can be concluded that the soil of area found to be in moderately alkaline to strongly alkaline reaction range with conductivity less than 1 dSm^{-1} implied that soil suitable for cultivation of the most of crop plants without major problem.

Soil found to be low to medium in organic C and available N, all samples of phosphors found in medium range. But soil K found to be high fertility status. Zn, Mn and Cu status of study area found to be in sufficient range but Fe found in marginal to sufficient range. Also, the fertility maps prepared were very helpful in spatial fertility management in the farm area.

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