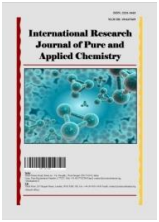

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# Soil Fertility Evaluation and GPS-GIS Based Soil Nutrient Mapping of Krishi Vigyan Kendra, Palem, Telangana

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***Authors' contributions***

*This work was carried out in collaboration among all authors. Author KR designed the study, analyzed soil samples, wrote the protocol and wrote the first draft of the manuscript. Author NH mapped the soil fertility status and author MR helped in drafting of the paper. All authors read and approved the final manuscript.*

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## ABSTRACT

Soil fertility evaluation of an area is an important aspect in the context of sustainable agriculture production. In the present investigation KVK, Palem farm was selected in the district Nagarkurnool of Telangana and studied physico-chemical, available macro and micronutrient status using Nutrient Index approach made with the study of 60 surface soil samples and were analyzed for pH, Electrical Conductivity (EC), Organic Carbon (OC), Nitrogen (N), Phosphorus (P), Potassium (K) and micronutrients (Fe, Mn, Cu and Zn). Study results indicated that a major proportion of area soils are neutral (62.08%) and non-saline (100%). The whole study area was low in organic carbon content, ranging from 0.40 to 0.45 with a mean of 0.42%, and available nitrogen also low in the entire study area varied from 150.53 to 188.16 kg $ha^{-1}$ with a mean value of 165.67 kg $ha^{-1}$. The percent

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distribution of available P varied from medium to high status (34.48 and 72.41%), where available K was categorized under high (100%) status. With regard to micronutrients, the soils were predominantly deficient in Zn (24.13%) followed by Fe (20.68%) and Mn (6.89%).

*Keywords: Nutrients index; soil properties; nutrient mapping; macro and micronutrient status.*

## 1. INTRODUCTION

The major challenges of 21st century are food security, environmental quality and soil health which play an important role in providing essential ecosystem services to human life. Besides, shrinking of landholdings and increasing cost of inputs necessitate induction and adoption of scientific use of plant nutrients for sustaining crop productivity. To increase the capacity of these soils to enhance crop yields and to increase the income of smallholding farmers, the spatial distribution of soil nutrients needs to be mapped and recommended for appropriate fertilizer usage. The mapped results of soil nutrients could then be used for effective monitoring of changes that might occur between cropping systems and seasons over-time, Mandal and Sharma, [1]. Global Positioning Systems (GPS) and Geographic Information Systems (GIS) are widely utilized for delineating fertility maps to describe spatial variability of soil fertility across field areas, Mishra et al. [2]. Based on the geo-statistical analysis, several studies have been conducted to characterize the spatial variability of different soil properties, Weindorf and Zhu, [3] and Liu et al. [4]. Among the different geo-statistical methods, ordinary kriging is widely used to map spatial variation of soil fertility because it provides a higher level of prediction accuracy, Song et al. [5]. Hence, developing spatial distribution maps of soil nutrients will help to refine agricultural management practices, as well as provide a base for future site-specific nutrient management, Fairhurst et al. [6] for various crops grown at KVK, Palem. Therefore an attempt has been made in the present investigation to prepare GIS and GPS based soil fertility maps for KVK, Palem farm to find out the soil fertility related production constraints of the farm and to suggest remedial measures for optimum production of crops, which might be useful for conducting research trials.

## 2. MATERIALS AND METHODS

Krishi Vigyan Kendra (KVK), Palem was established in the year 2011 under Professor Jayashankar Telangana State Agricultural University (PJTSAU), Nagarkurnool District. The farm is located at 16° 51´N latitude and 78° 24´ E longitude which comes under Southern Telangana Zone of Telangana. The zone is characterized by hot and dry with an average rainfall of 853 mm annually received mostly from the south-west monsoon. The zone has red clayey soils (22.3%), red gravelly loam (16.5%), and alluvio-colluvial soils (14.4% of the area). As a whole, the zone is dominated by different textured red soils with varied depths to an extent of 54.8 per cent and is followed by alluvio-colluvial soils and calcareous soils (11.2%).

A total of 60 geo-referenced surface soil samples (0-15 cm depth) were collected after the harvest of crops on a grid basis according to operational guidelines given by Department of Agriculture and Cooperation, Government of India for rainfed areas, DoAC, [7]. The samples were properly labeled, air-dried, and processed for analysis of soil parameters. The physico-chemical soil properties (pH and EC) were determined by standard procedures, Jackson, [8], whereas organic carbon content was estimated by wet oxidation method, Walkley and Black, [9]. Available nitrogen (N) was estimated by alkaline permanganate method, Subbaiah and Asija, [10], available phosphorus (P) was determined using sodium bicarbonate (0.5N NaHCO3) extractant at pH 8.5 by Olsen et al. [11] and available potassium (K) was extracted by neutral normal ammonium acetate and measured on flame photometer, Muhr et al. [12]. As well as available micronutrients (Fe, Mn, Cu and Zn) were extracted by DTPA extractant, Lindsay and Norvell, [13] and determined ins Atomic Absorption Spectrophotometer (AAS). Further, Nutrient Index Value (NIV) was calculated by Ramamoorthy and Bajaj's, [14] index method after the classification of soil samples based on soil test values of different nutrients in three categories *viz.*, low, medium, and high and it is calculated as per the following equation.

$$NIV = (NL \times 1 + NM \times 2 + NH \times 3) / 100$$

where, NL, NM and NH are the number of samples in low, medium and high fertility classes of nutrient status, respectively and NT is the total number of samples. The index values are rated

into various categories *viz*., low (<1.67), medium (1.67-2.33) and high (>2.33) for OC and available N, P and K. For available S and micronutrients, the ratings are very low (< 1.33), low(1.33-1.66), marginal (1.66-2.00), adequate (2.00-2.33), high (2.33-2.66) and very high (> 2.66). The research blocks were categorized into different fertility ratings based on the % sample category and NIV. Database on soil nutrient status was imported into GIS environment and soil fertility maps generated by krigging method using Arc-GIS software by categorizing the fertility status as 'Low', 'Medium' and 'High' with an appropriate legend.

## 3. RESULTS AND DISCUSSION

### 3.1 pH and Electrical Conductivity

The results presented in Fig. 1 indicated that the pH of the KVK, Palem farm ranges from 6.03 to 7.80 with a mean pH of 7.16. Among the soil samples tested, most of the soils were under neutral range (62.08%) followed by slightly alkaline (34.48%) and slightly acidic (6.89%) in reaction. A similar type of observations was recorded by Vivekananda Aich, [15] at College of Agriculture, Pune. The EC of soil samples were ranged from 0.14 to 0.33 $dSm^{-1}$, with an average mean value of 0.23 $dSm^{-1}$ and, all samples (100%) were non-saline. The results indicated that the entire study area normal in nature and suitable for all types of crops and similar results were reported by Shinde and Patil, [16] at Agriculture College farm, Nandurbar, Maharashtra.

#### 3.1.1 Organic carbon (%)

The organic carbon content (%) varied from 0.40 to 0.45with a mean of 0.42% (Fig. 1) and all the samples (100%) were low in organic carbon status. The study area is well aerated with a warm arid climate and decomposes added materials rapidly, which might be the reason the organic matter is low in the study area. Similar observations were recorded by Raj et al. [17] in soils of Telangana.

### 3.2 Available Major (N, P and K) Nutrient Status

The available nitrogen status in the surface soils ranged from 150.53 to 188.16 kg $ha^{-1}$ with an overall mean value of 165.67 kg $ha^{-1}$(Fig. 2). Among the blocks, highest percentage of low available N status (100%) was recorded, while the nutrient index value registered as 1.0 which indicating the overall fertility rating for available nitrogen status was low. As the majority of soils are light textured and alkaline in reaction, the applied nitrogenous fertilizer would have resulted in a low amount of available N in the soil, and these results were in confirmation with the findings of Sharma et al. [18].

The available phosphorus ranged from 43.72 to 78.70 kg $ha^{-1}$ with an overall mean value of 63.32 kg $ha^{-1}$. The overall percent category falls under medium and high as 34.48 & 72.41% and there is no block found with low available phosphorus status (Fig. 2). The similar trends of available phosphorus were also reported by Shinde and Patil, [16] in soils of Nandurbar Agriculture college farm. Among the blocks of KVK, Palem farm registered nutrient index values of 2.85 for available P status by specifying a higher percentage of high category. This high status of P in majority of soils may be attributed to continuous application of phosphatic fertilizers during the crop growing period, which would have resulted in a buildup of available phosphorus. These results are confirmed with the findings of Sharma et al. [18].

The mean values of available potassium status recorded in the surface soils of different blocks varied from 356 to 528.19 kg $ha^{-1}$with a mean value of 436.24 kg $ha^{-1}$. Almost all the samples were categorized under high (100%) status of KVK, Palem farm (Fig. 2), and the nutrient index value registered as 3 and recommended potassium dose should be sufficient for the crops grown in the farm. The higher status of available K is attributed to the prevalence of potassium bearing minerals in these soils, Maragatham et al. [19]. Similar results of available K were also reported by Kadam, [20] in soils of Agriculture College farm, Karad.

### 3.3 Available Micronutrients (Zn, Cu, Fe and Mn) Status

The range and mean values of micronutrient status in the soils of KVK, Palem presented in Fig. 3. The available Zn status ranged from 0.46 to 4.61 mg $kg^{-1}$with a mean value of 1.17 mg $kg^{-1}$ indicating an insufficient to a sufficient range of zinc status. About 24.13% of samples alone were insufficient in available Zn and 75.86% of the samples were in sufficient status. The nutrient index value for available zinc was 0.73 and is the line with the findings of Sellamuthu et al. [21]. The conversion of zinc cations to their oxides or hydroxides at higher pH, which is known to have lower solubility, might be the reason for low zinc status.

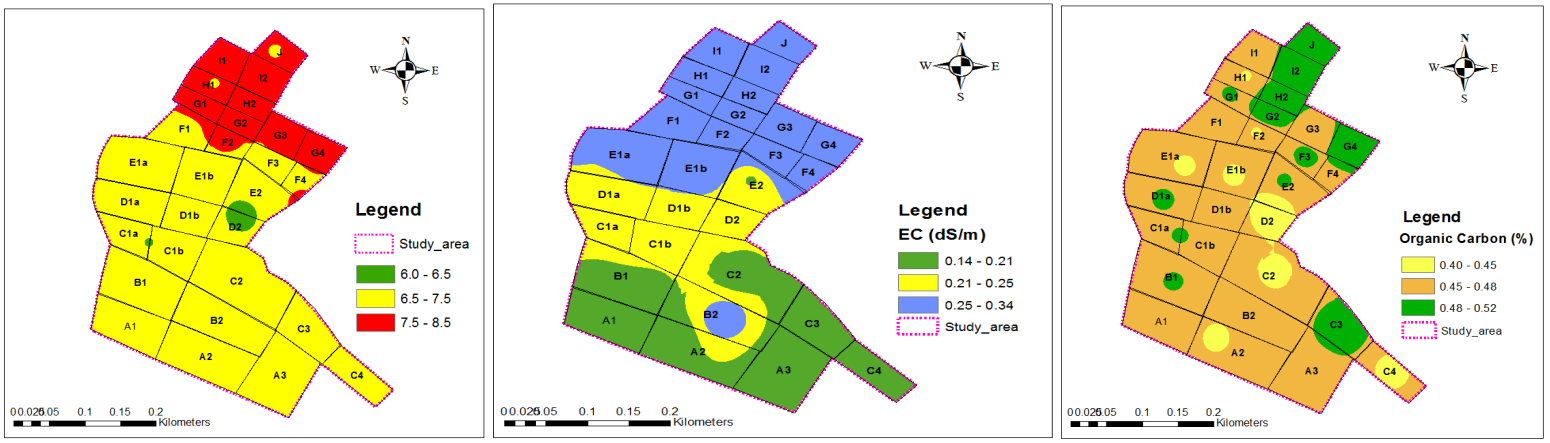


**Fig. 1. Physico-chemical (pH, EC & OC) properties of KVK, Palem**

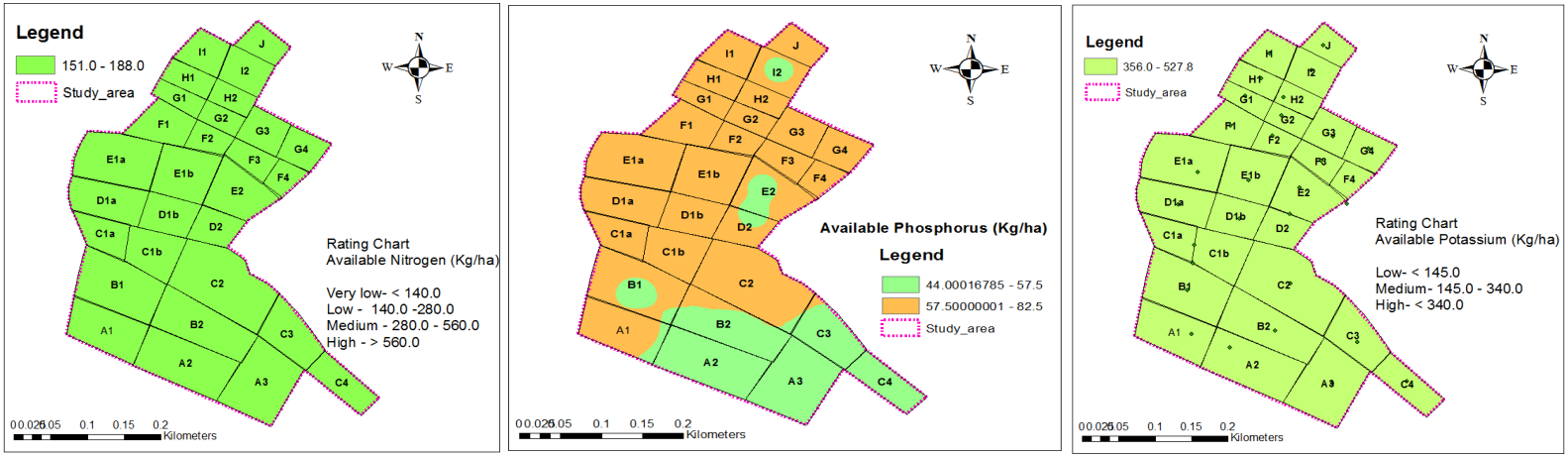


**Fig. 2. Available macro nutrient (N, $P_2O_5$& $K_2O$) status of KVK, Palem**

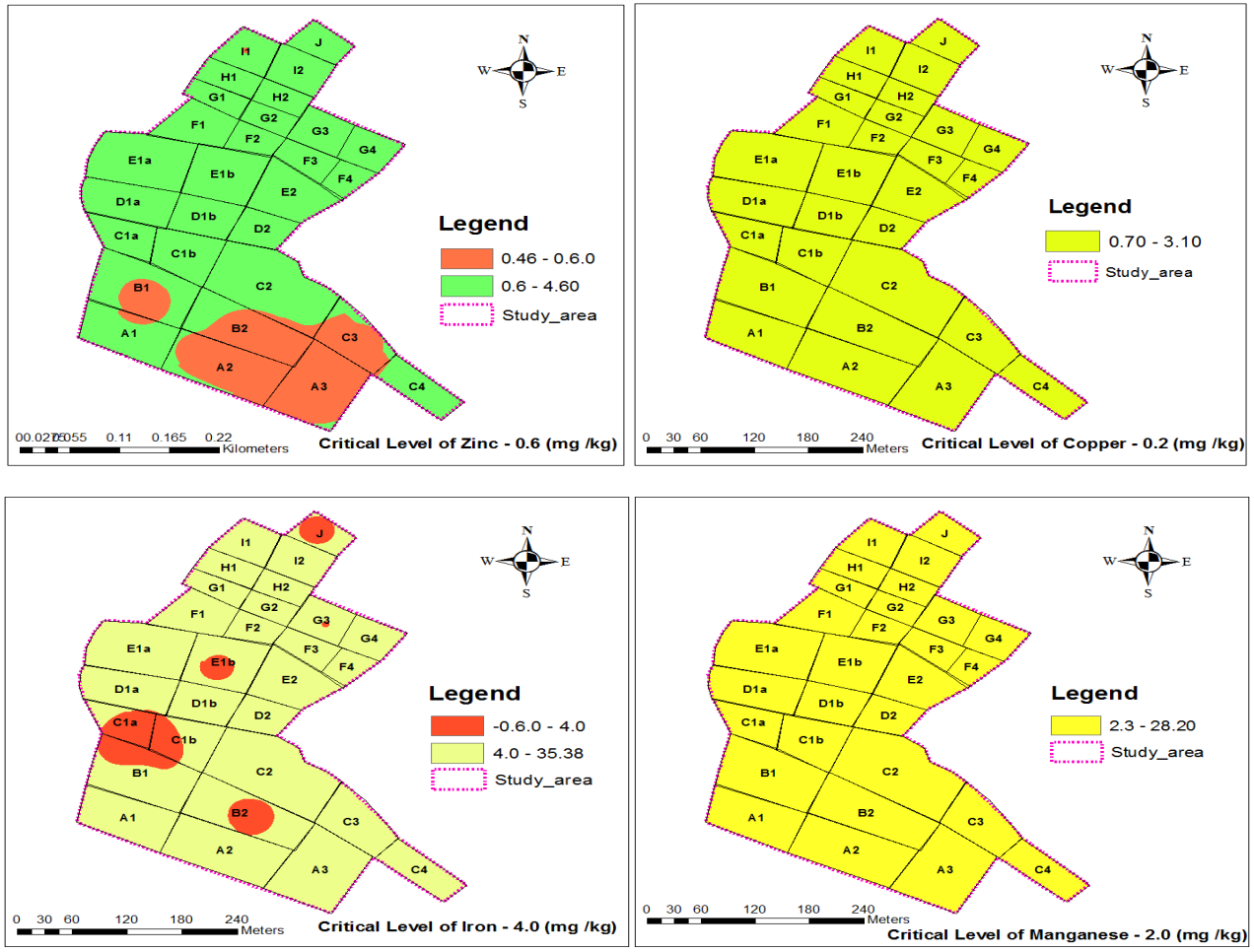


**Fig. 3. Status of available micro nutrients (Zn, Cu, Fe &Mn) at KVK, Palem**

The available copper status varied from 0.79 to 3.03 mg $kg^{-1}$ with a mean value of 1.80 mg $kg^{-1}$. Among the blocks, the highest available Cu was observed and the nutrient index value registered as 3, indicating sufficient status of available Cu in KVK, Palem farm (Fig. 3). It may due to agricultural practices can add copper to soils through the application of manures, inorganic fertilizers, and fungicides, Novoa-Munoz et al. [22]. Being high status of available copper in the soil, care should have to take during fungicide, pesticides, herbicides application in the field because these chemical already contains copper element, Husak, [23] and it may reduce seed germination, inhibition of root and shoot growth, disturbance on photosynthetic pigments, Adrees et al. [24] of crops grown in KVK, Palem farm further.

The available Fe status varied from 0.62 to 35.41 mg $kg^{-1}$ with a mean value of 8.68 mg $kg^{-1}$ and it distributed from insufficient to sufficient range (Fig. 3), although sufficient status was prevalent in the farm and similar results also determined by Khadka et al. [25]. The available iron overall status was 20.68%insufficient and 79.31% insufficient, while the nutrient index value registered as 2.58, due to occurrence of primary and secondary iron-containing minerals such as hematite, olivine, siderite, goethite, magnetite, Havlin et al. [26].

The available Mn status varied from 2.29 to 28.22 mg $kg^{-1}$with a mean value of 17.7 mg $kg^{-1}$ and almost all blocks (93.1%) had sufficient Mn status, while 6.89% samples showed insufficient available Mn status at KVK, Palem (Fig. 3) with the nutrient index value of 0.83. The higher Mn status in the soils may be attributed to the lower oxidation under optimum soil reaction of the soils and also due to the release of chelated Mn from the organic compounds. Similar findings were reported by Arokiyaraj et al. [27].

## 4. CONCLUSION

It can be concluded that the soils of KVK, Palem farm were slightly acidic to slightly alkaline in soil reaction, non-saline, and low in organic carbon content. The soil fertility for major nutrient status indicated that the soils were low in N, medium to high in P, and high in K. Among the micronutrients, Zn and Fe are insufficient to some extent in the farm, while Cu and Mn were sufficient range. Further, the fertility maps of KVK, Palem farm will enable the researcher to formulate new fertilization schedules on a sound scientific footing to improve crop yields sustainably and to monitor soil health to workout appropriate soil reclamation measures to increase soil biodiversity.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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