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Assessment of Soil Fertility Status of Mango Orchard at Vikarabad Farmhouse in Manneguda Village of Telangana State of India

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ABSTRACT

The present research study was conducted at the Farmhouse, located in Gangupally village of Vikarabad, to find out the soil fertility status. The soil samples were analyzed based on physical, physiochemical, and chemical properties. The soils of Mango orchards in Manneguda village at Vikarabad district in Telangana state at 0-30 cm depth were studied by using standard analytical methods. The results showed that the sand content was higher than the clay content. The majority of the soil textural class was sandy clay loam (50.08%) followed by clay loam (38.0%). and Clay (11.92%). Organic Carbon was found to be as low to medium, soil pH was neutral to moderately alkaline in reaction, Electrical Conductivity (EC) of these soils was normal in condition, (C1) available nitrogen was low, and available phosphorus was low to medium in range. All the locations recorded medium to a high amount of available potassium The majority of soil locations recorded sufficient calcium, magnesium, and sulfur content. Among micronutrients, zinc, and boron were deficient in these soils. Although the soil fertility status is low to medium, it can be enhanced through the application of soil test-based fertilizers, recommendations, and proper management practices, to achieve the targeted yields of Mango and other crops. Mango is the national fruit and deserves nationwide attention to achieve the top position in the world, it retains the title of the national fruit, and helps the farmers to get profit from the mango orchards.

Keywords: *Organic carbon, EC -Electrical conductivity, micronutrients, and, orchard management.*

INTRODUCTION

The Farm House was established in the year 1984 and the Mango orchard is sprawling and spread over 73 acres of land area. Farming of Mangoes is done in summer and flowering plants are grown in winter. The soils are red soils with Natural Compost (plant and animal manures), Mustard cake and vermicompost are also added for plant growth. There are about 5000 Mango trees in the orchard. The type of lawn is crabgrass and Napier grass, which is grown as fodder for cattle. Water supply to the farm is through drip irrigation and the Farming of corn, castor, Guava, and Falsa is also done in the farmhouse. Flowering plants like pansies, petunias, marigolds, Christian flowers, zinnia, dahlias, salvia, lilies, passionflower, orange trumpet vine, exotic roses exotic hibiscus varieties.,orchids, Fruit trees like *Citrus paradisi and, Spathodea campanulata, Alpinia zerumbet, Dracaena surculose, Ficus centifolia , Adenium Bonsai, Tagetus, Codiaeum variegatum, Costus spiralis, Tectona grandis, Averrhoa carambola, Mussanda frondosa, etc.*

Soil fertility and nutrient management are the main factors that have a direct impact on crop yield and quality. Soil fertility is one of the important factors in controlling yields of the crops. Soil characterization in the evaluation of the fertility status of the soils of an area or region is an important aspect in the context of sustainable agricultural production. The imbalanced and inadequate use of fertilizers, coupled with the low efficiency of other inputs and chemical fertilizer nutrients' response production efficiency has declined tremendously under intensive agriculture in recent years [19]. The physicochemical properties such as pH, electrical conductivity, organic carbon, and calcium carbonate are important in deciding the availability of essential nutrients in the soil and thereby for crop production. The supply of essential nutrients from soil can be augmented by proper management of these properties. The macronutrients governed the soil's fertility and controlled the crop' yield. Crop nourishment in any region depends remarkably on soil nutrient availability on their profile similarities. All these problems make it necessary to analyze the physicochemical status of agricultural soils if they are managed for the benefit of individual farmers and mankind.

Soil productivity is the ability of the soil to produce crop/unit area. Therefore fertile soil could or could not be produced depending upon crops, marketing conditions, and many other factors (excessive acidity/ alkalinity, presence of toxic substances, poor physical properties, or deficiency of water). However, every productive soil has to be fertile. Soil productivity generally depends upon soil fertility to a great extent.

Mango (*Mangifera indica* L.) has become a major fruit crop of the tropics and subtropics, particularly in Asia, the most important fruit crop and where it has always been considered the king of fruits [18]. India provides about 50 percent of the world's mango production, with the largest area of more than 40 percent of the total fruit area. The area occupied by Mango in India is 22.58 lakh hectare, where the annual production and productivity is 218.22 lakh MT and 9.7 MT/ ha respectively as against a higher productivity of 30 MT/ ha in Israel. Andhra Pradesh leads in the area of mango cultivation, occupying 3.63 lakh hectares followed by Uttar Pradesh occupying 2.65 lakh hectares whereas Uttar Pradesh leads in the production of 45.51 lakh MT followed by Andhra Pradesh producing 43.73 lakh MT and Rajasthan leads in productivity of 17.58 MT/ ha followed by Punjab of 16.9 MT/ ha (NHB, 2019-20) in YSR district of Andhra Pradesh mango is in the dominant area with the other fruit crops like banana, papaya, and sweet orange, *etc*. The productivity of mango is hampered due to the limited use of fertilizers and pesticides [28]. The nutrition of fruit plants depends upon the inherent ability of soils to supply nutrient elements. The key to the mineral nutrition of plants is the judicious use of fertilizers based on soil testing. Plant analysis is also used to confirm the suspected deficiencies and toxicities of nutrients and assess the fertilizer doses' efficacy [26]. Therefore, it is very important to focus on the soil nutrient availability and other properties of nutrients, if mango production is to be increased. Total nitrogen, phosphorus, potassium, sulfur, calcium, and magnesium content in soils and their availability to the plants are vital properties of soil fertility. The soil nutrient of mango is an important part of the orchard management practices [22]. Essential nutrients have a specific role in the plant and their presence is a must for the plant to complete its life cycle. Information on mineral nutrient status helps diagnose nutritional problems and estimate the fertilizer needs of fruit trees [26]. Therefore, to ascertain these both soil and plant analyses are necessary as these are complementary to each other and one provides the information and not the other. The information on the nutritional status of both soil and plant helps to understand adequate fertilization of the orchards.

Because of the above scientific background, soil samples were collected from the mango orchard farm established in 1984 and spread to about 73 acres at Manneguda village in the Vikarabad district of Telangana State. These soil samples from this Mango orchard farm were analyzed for Physical, physical-chemical, and Nutrient properties, as major, and micronutrient contents to assess the Soil Fertility. The status of this Mango Orchard Farm was taken up in the investigation and presented in this research paper.

MATERIALS AND METHODS

The fertility status of selected mango orchard soils at Manneguda village in Vikarabad, district of Telangana state was evaluated. Ten soil samples (0 - 30 cm depth) were collected. Soil samples were collected from the Mango orchard, the back side of the Farmhouseuse, the swimming pool, in front of the Mango groove, near the Building, and the entrance of the Farmhouse. Soil samples were air-dried, visible roots and debris were discarded, and massive aggregates were broken by using a wooden hammer, ground, and sieved using a 2 mm sieve. Samples were kept in polyethylene bags with proper labeling. Particle size distribution (mechanical composition) of the soils was determined by the Bouyoucos hydrometer method [5]. Based on the particle size distribution, soil texture was classified by using a *nomograph* (textural diagram) of USDA Hand Book 60. Soil reaction expressed as pH was determined in 1:2.5 soil water suspension using Systronics pH meter model-361, with a glass electrode [14-15]. The electrical conductivity of the

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soil was determined in 1:2.5 soil water extract with help of Systronics digital electrical conductivity meter model-306 and was expressed in dS $m^{-1.}$ The organic carbon content in the 0.2 mm sieve soil sample was estimated [32] methods, was outlined [14-15], and was expressed in percentage.

Soil-available nitrogen was estimated by the alkaline permanganate method as described by [27] and was expressed in kg ha Soil-available able phosphorus was extracted by using 0.5 M NaHCO3 adjusted to pH 8.5 [21] color intensity was read in a spectrophotometer at 660 nm and was expressed in kg ha^{-1}. Soil-available potassium was extracted with neutral normal ammonium acetate and the content was estimated as per the procedure outlined [14 – 15] using a flame photometer and was expressed in kg ha^{-1}.

Available sulfur in the soil was determined by extracting the soil sample with 0.15% calcium chloride [33] and Sulphur content in the extract was determined by turbidimetric method [8] using a spectrophotometer at 420 nm and was expressed in mg kg^{-1} of soil. Exchangeable calcium and magnesium were determined in neutral normal ammonium acetate extract and the contents were determined by following the versant titration method [31] and were expressed in centimole (p+) kg^{-1} of the soil. The DTPA extractable Micronutrient contents (Zn, Cu, Mn, and Iron) in soils were determined using the [17] method and interpreted using the [6] procedure. Hot water extractable Boron was estimated as per the procedure laid out by [13].

Fig 1. Collection of Soil Samples from the Vikarabad Farmhouse

RESULTS AND DISCUSSION

The pH of soils of the study area varied from 7.82 to 8.25 with a mean value of 8.03. The lower pH of surface soil might be due to the presence of more amount of organic matter, which resulted in the release of organic acids during its decomposition. Probably this might have brought down the pH of surface soils. The higher pH showed in the sub-surface soils might be due to low

organic matter and leaching of exchangeable bases to lower horizons. The higher pH values in orchard soils could be attributed to comparatively less leaching of bases in fine-textured soils like sandy clay and sandy clay loam. Similar results were reported by [1], [9], and [29]. The electrical conductivity of the soils in the study area ranged from 0.185 to 0.245dS $m^{-1}$with a mean value of 0.215 dS $m^{-1}$and the soils were non-saline, with a mean value of 0.215 (Table1). All the locations showed that EC was within the normal range and soils were free from saline problems, because of good drainage conditions leading the leaching of salts to lower horizons. The orchards were non-saline as the EC of these soils was far below 4.0 dS m^{-1}. The normal electrical conductivity (<0.5 dS m^{-1}) observed from this study was favorable for satisfactory plant growth.

The Organic carbon (OC) content of soils (Table 1) of all study area locations falls under the low to medium range. The OC content of soils varied from 0.435 to 0.575 percent, with a mean of 0.505 percent (Table1.).

Table 1: pH, E.C., Org. Carbon and Major Nutrients (N, P2O5, and K2O) of Study area of Mango Orchard

Sample location details	pH (1:2.5)	E.C. (Ds m^{-1})	Org. Carbon (%)	Available Nutrients (kg ha^{-1})		
				Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)
A	7.82	0.215	0.435	155.10	21.65	274.50
B	7.95	0.185	0.450	167.25	19.75	282.50
C	8.15	0.235	0.525	186.50	27.25	291.15
D	7.93	0.205	0.575	214.50	29.60	272.50
E	8.25	0.245	0.525	202.75	31.25	284.50

Table 2: Soil Texture and Exchangeable Cations of Study area of Mango Orchard

Sample Location Details	Soil Texture	Exch. Potassium (Meq/100g)	Exch. Sodium (Meq/100g)	Exch. Calcium (Meq/100g)	Exch. Magnesium (Meq/100g)
A	CLAY LOAM	0.313	0.220	5.675	2.042
B	SANDY CLAY LOAM	0.325	0.246	4.625	2.270
C	CLAY	0.334	0.295	5.752	2.663
D	CLAY LOAM	0.311	0.225	5.265	1.850
E	CLAY	0.325	0.315	5.850	2.048

Table 3: C.E.C., of Chlorides, Sulphur, and water retention of the Study area --Mango Orchard

Sample Location Details	C.E.C. (Meq/100g)	Chlorides (Meq/ 100g)	Sulfur (mg/kg)	Field Capacity (%) Water Retention at 0.33 b	Wilting Capacity (%) Water Retention at 15.0 b	Maximum Water Retention Capacity (%)
A	6.525	3.265	7.25	27.25	5.35	21.90
B	7.466	3.750	7.620	22.50	4.85	17.65
C	9.250	4.125	8.450	29.11	6.75	22.36
D.	7.651	3.825	8.750	30.75	5.50	25.25
E.	8.538	4.205	9.211	32.50	6.25	26.25

Table 4: Micro Nutrients (Z, Cu, Fe, and Mn) of Study area of Mango Orchard

Sample Location Details	Available Micronutrients in mg/kg				
	Zinc	Copper	Iron	Manganese	Boron
A	0.610	0.195	5.175	4.925	0.455
B	0.575	0.210	5.230	6.335	0.475
C	0.610	0.235	5.850	6.750	0.515
D.	0.575	0.225	5.125	6.255	0.525
E.	0.635	0.217	4.250	6.750	0.485

The available nitrogen content of the soils varied from 155.10 to 214.5 kg ha^{-1}, with a mean value of 184.8 kg ha^{-1}(Table 1.). The variation in N content might be due to several reasons such as differences in natural fertility, variation in cultural practices, and variation in the N-applied fertilizers. Available Nitrogen contents in surface soils were higher as compared to the lower depths of soils, which might be due to the presence of more organic matter in surface than sub-surface soils. Similar results were reported by [16].

The available phosphorus status of study area soils(Table 1) was low to medium and ranged from 19.75 to 31.25 kg ha^{-1}, with a mean value of 25.5 kg ha^{-1}. It might be due to the confinement of crop

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cultivation to the rhizosphere and supplementing the depleted P by external sources like *fertilizers*. The lower P content in sub-surface compared to surface soil was due to the fixation of released P by clay minerals and oxides of iron and aluminum. Similar results were reported by [16].

The available potassium content of study area soils (Table 1) ranged from 272.5 to 291.15 kg ha, with a mean value of 281.8 kg ha^{-1}. Soils of all locations in this mango orchard soil were medium in available potassium. This might be due to more intense weathering, the release of liable K from organic residues, the application of K fertilizers, and the upward translocation of K from lower depths along with capillary rise.

The soil Texture of the study area is medium to heavy textured soils and ranged from sandy clay loam to clay. (Table 2). Soil Textural analysis revealed that surface soils of spots A, B, C, D, and E were ranging sandy clay loam, while spots C, D, and E had Clay loam textured to layer with deeper depths being sandy clay loam at B location of soils. Due to the medium textured and heavy textured soils, these soils are best suitable for Mango orchard cultivation [3].

The available sulfur content of soils of the study area of this mango orchard (Table 3) recorded mean values under the efficient range (<10 mg kg^{-1}) of available sulfur content under the deficit range (<10 mg kg^{-1}) as per the S critical limit (<10 mg kg^{-1}) as prescribed by [30)]. Similar results were reported by [10]. The available calcium and magnesium content of the study area varied from 4.625- to 5.850 and 1.85 to 2.27 cm (p+) kg^{-1} with mean values of 5.238 and 2.06 centimole (p+) kg-1 respectively.

The soils of all the locations were above the critical limit in both calcium and magnesium contents. The exchangeable calcium and magnesium status observed in all the orchards both in the surface soils were above the critical limit of <1.50 centimole(p+) kg^{-1} as established by [30]. The Cation Exchangeable Capacity (C.E.C.) of these soils was normal. (Table 3) and ranged from 6.525 to 9.250 Meq/100g with a mean value of 7.890 Meq/100g.

The Field capacity, Wilting Point, and Maximum water holding capacity of these soils were estimated using Pressure plate apparatus. The estimations indicated that they were ranging from 22.50 to 32.50%; 4.85 to 6.75% and 17.65 to 26.25% respectively. The mean values were 27.5%, 5.80%, and 21.95% respectively (Table 3). Water retention capacity was lower in medium-textured soils than compared to heavy-textured soils. The hydraulic properties of the soils including saturated hydraulic conductivity, soil moisture at field capacity, permanent wilting point, and maximum water holding capacity had a significant correlation with silt + clay content, clay content, bulk density, and soil organic carbon content of the soils. These results comply with [25].

The soils of all the locations (Table 4) were deficient in available zinc ranging from 0.575 to 0.635 mg/kg with a mean value of 0.605 mg/kg and below the critical limit of 0.65mg/kg. These soils are sufficient in available Copper, Iron, and Manganese contents and they are ranging from 0.195-0.235; 4.250-,5.850, and 4.925-6.750mg/kg respectively. The respective mean values for Copper, Iron, and Manganese contents were 0.0215, 5.05, and 5.84 and they are above the critical limits of 0.20, 4.0, and 2.0 mg/kg of soil respectively. Some of these soils were deficient in hot water extractable boron and it ranged between 0.455 and 0.485 mg/kg with a mean value of 0.470 mg/kg of soil. Out of the five locations, only two locations namely C and D were sufficient in Boron and they are 0.515 and 0.525 mg/kg of soil respectively. Micronutrient deficiencies have become one of the major constraints in sustaining crop production in the present exploitive agriculture [11].

These deficiencies appeared much faster in the southern states as compared to other parts of the country. The deficiencies may be attributed primarily to the fast adoption of new agricultural technology, including cultivation of high-yielding crop varieties, increase in cropping intensity, expansion of irrigation facilities, increased use of high-analysis fertilizers, and poor quality irrigation water [20]. Boron deficiency in mango is very common but farmers seldom take corrective measures, if properly applied the correction of boron deficiency is very easy. Applying B to the soil can provide unsatisfactory results during dry seasons and may result in toxicity problems. Basal application of boron through broadcast on surface soil is better than top dressing in boron-deficient soils [12].

CONCLUSIONS

Thepresentstudywasconductedtofindoutsoilfertility status through analyzing physical, physiochemical, and chemical properties of representative soils of Mango orchards in Manneguda village of Vikarabad district in Telangana state at 0-30 cm depth by using standard analytical methods to find out fertility status of these orchard soils. The results show that sand content was higher than clay content majority of the soil textural class was sandy clay loam (50.08%) followed by clay loam (38.0%). and Clay (11.92%). Organic carbon was found as low to medium, soil pH was neutral to moderately alkaline in reaction, EC of the soils was normal in a condition where available nitrogen was low, available phosphorus was low to medium in range, and all the locations were on an average to a medium and high level of available potassium. All the locations recorded sufficient calcium, magnesium, and sulfur contents. Among micronutrients, zinc, and boron was deficient in these soils. Although the soil fertility status is low to medium, it can be enhanced through the application of soil test-based fertilizer recommendations and proper management practices to achieve targeted yields of Mango and other crops [23].

Mango is national fruit and deserves nationwide attention to achieve the top position in the world, to retain the title of national fruit, and, to help the farmers to make a profit from mango orchards. Available evidence suggests that the yield gap between average farm yields be achieved from a mission mode to adopt the available technologies of orchard management across the country to enhance the productivity, yield, and, profitability of mango orchards and achieve the goal of doubling the income of mango farmers by 2022 [12].

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