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Studies on soil nutrient constraints in groundnut growing soils of Kudligi Taluk, Vijayanagara district of Karnataka

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Abstract
Soil nutrient availability is an important factor influencing groundnut productivity, particularly in rainfed production systems. The present investigation assessed the soil nutrient status of groundnut-growing soils in Kudligi taluk of Vijayanagara district of Karnataka. Sixty surface soil samples (0-30 cm) were collected from eight selected villages: Kanahosahalli, Poojarahalli, Badaladaku, Shivapura, Gudekote, Chikkajogihalli, Appenahalli and Moraba. Soil samples were analysed for pH, electrical conductivity (EC), organic carbon, available nitrogen, phosphorus and potassium and DTPA-extractable iron, manganese, copper and zinc. Soil pH ranged from 6.43 to 8.68, while EC ranged from 0.05 to 0.86 dS m^{-1}, indicating that the soils were non-saline. Organic carbon ranged from 0.12 to 0.98 per cent, with a reported mean of 0.51 per cent. Available nitrogen, phosphorus (P_2O_5) and potassium (K_2O) ranged from 100.26 to 390.51, 15.65 to 35.97 and 127.65 to 385.26 kg ha^{-1}, respectively. Among the micronutrients, DTPA-extractable Fe, Mn, Cu and Zn ranged from 7.31 to 34.48, 2.10 to 23.80, 1.02 to 2.76 and 0.01 to 1.27 mg kg^{-1}, respectively. The very low zinc value at Chikkajogihalli indicated a potential micronutrient constraint, while low organic carbon and nitrogen were important concerns in parts of the study area. The findings highlight the need for soil-test-based nutrient management, organic matter improvement and zinc application where deficiency is confirmed.

Keywords: Groundnut, soil survey, soil fertility, nutrient management

Introduction
Soil fertility is a key determinant of crop growth and sustainable agricultural production. It depends on the physical, chemical and biological characteristics of soil and on the availability and balance of essential plant nutrients. Continuous cultivation, inadequate nutrient replenishment and imbalanced fertilizer use can contribute to the depletion of soil organic matter and plant nutrients. Assessment of soil nutrient status therefore provides a basis for identifying fertility constraints and developing appropriate nutrient-management practices.

Groundnut (*Arachis hypogaea* L.) is an important food and oilseed crop in Karnataka, particularly in rainfed areas. Its growth, nodulation, pegging, pod development and yield are influenced by soil nutrient availability and soil moisture. Although groundnut can meet part of its nitrogen requirement through symbiotic nitrogen fixation, adequate nutrient supply, including phosphorus, potassium and essential micronutrients, remains important for crop development. Earlier studies on groundnut-growing soils in Karnataka and other regions have documented variation in available nutrients and soil fertility characteristics (Ranganayakulu *et al*., 1986; Munaswamy *et al*., 1989; Pradeep *et al*., 2006; Manasa *et al*., 2020) [6, 7, 9, 11].

Kudligi taluk of Vijayanagara district falls within the Northern Dry Agro-Climatic Zone of Karnataka. Agriculture is predominantly rainfed, and groundnut is among the important crops grown in the region. The semi-arid climate and variation in soil characteristics make it important to evaluate soil nutrient availability across groundnut-growing locations. Accordingly, the present paper addresses the objective: to assess the soil nutrient status in groundnut-growing areas of Kudligi taluk.

Materials and Methods
1. Study area and sampling
The investigation was conducted in eight selected groundnut-growing villages of Kudligi taluk, Vijayanagara district, Karnataka: Kanahosahalli, Poojarahalli, Badaladaku, Shivapura, Gudekote, Chikkajogihalli, Appenahalli and Moraba. Kudligi is situated at approximately 14.77° N latitude and 76.43° E longitude and falls under the Northern Dry Agro-Climatic Zone. The region has a semi-arid climate and predominantly sandy loam soils. With assistance from the Agricultural Extension Education Centre (AEEC), Huvina Hadagali, groundnut-growing farmers were identified. Sixty farmers with more than 10-15 years of experience in groundnut cultivation were selected and 60 surface soil samples were collected at 0-30 cm depth.

2. Soil sample preparation and analysis
Collected samples were air-dried in shade, ground with a wooden pestle and mortar, passed through a 2-mm sieve and stored in clean, dry containers before analysis. Soil texture was determined by the hydrometer method, bulk density by the core sampler method and maximum water-holding capacity by Keen's cup method (Piper, 1966) [8]. Soil pH

was measured potentiometrically in a 1:2.5 soil to water suspension and electrical conductivity was measured in the corresponding soil-water extract (Jackson, 1973) [2]. Organic carbon was determined by the Walkley and Black wet-oxidation method. Available macronutrients and DTPA-extractable micronutrients were determined using the procedures reported in the thesis methods. DTPA-extractable Fe, Mn, Cu and Zn were assessed following Lindsay and Norvell (1978) [5].

Results and Discussion

1. Soil reaction and electrical conductivity

Soil pH ranged from 6.43 to 8.68, with a mean of 7.75. The minimum pH was recorded at Kanahosahalli (V_1S_3), whereas the maximum was observed at Badaladaku (V_3S_1) (Table 1). The results show that the sampled soils varied from slightly acidic to alkaline, although the overall mean was in the slightly alkaline range. Differences in parent material, weathering, leaching and the accumulation of basic cations may contribute to spatial variation in soil reaction. The higher pH recorded at Badaladaku may reduce the availability of some micronutrients, particularly zinc, iron and manganese. Similar variation in soil reaction in groundnut-growing soils was reported by Munaswamy *et al.* (1989) [7], Pradeep *et al.* (2006) [9] and Leelavathi *et al.* (2009) [4].

Electrical conductivity ranged from 0.05 to 0.86 dS m^{-1}, with a mean of 0.20 dS m^{-1}. The lowest EC was recorded at Poojarahalli (V_2S_2), while the highest was observed at Badaladaku (V_3S_1). These values indicate that salinity was not a major constraint across the sampled soils. The relatively low mean EC may reflect leaching and drainage, while local differences may be associated with soil and water characteristics and nutrient-management practices. Comparable low EC values in groundnut-growing soils have been reported by Ranganayakulu *et al.* (1986) [11] and Leelavathi *et al.* (2009) [4].

2. Soil organic carbon and available nitrogen

Organic carbon ranged from 0.12 to 0.98 per cent, with a reported mean of 0.51 per cent. The minimum value occurred at Badaladaku (V_3S_2), and the maximum at Chikkajogihalli (V_6S_1) (Table 1). The wide range suggests substantial variation in organic matter status among sampling locations. Differences in farmyard manure application, crop-residue return, cropping intensity and decomposition may help explain this variation. Organic carbon supports soil aggregation, nutrient cycling, moisture retention and microbial activity; therefore, low values at some locations indicate a need to improve organic matter inputs. Similar relationships between organic carbon and soil fertility were discussed by Babu *et al.* (2002) [1], Jamuna *et al.* (2008) [3] and Pradeep *et al.* (2006) [9].

Available nitrogen ranged from 100.26 to 390.51 kg ha^{-1}, with a mean of 238.59 kg ha^{-1}. The lowest value was recorded at Gudekote (V_5S_4), whereas the highest was recorded at Kanahosahalli (V_1S_6). Lower available nitrogen in some soils may be associated with low organic matter, repeated crop removal and insufficient replenishment through manures or fertilizers. The relatively high value at Kanahosahalli may reflect differences in organic matter and nutrient management. As groundnut is a legume, biological nitrogen fixation contributes to its nitrogen economy, but it does not eliminate the need to maintain soil fertility and other nutrients. The observed variation is consistent with reports of differences in nitrogen status among groundnut-growing soils (Babu *et al.*, 2002; Jamuna *et al.*, 2008; Pradeep *et al.*, 2006) [1, 3, 9].

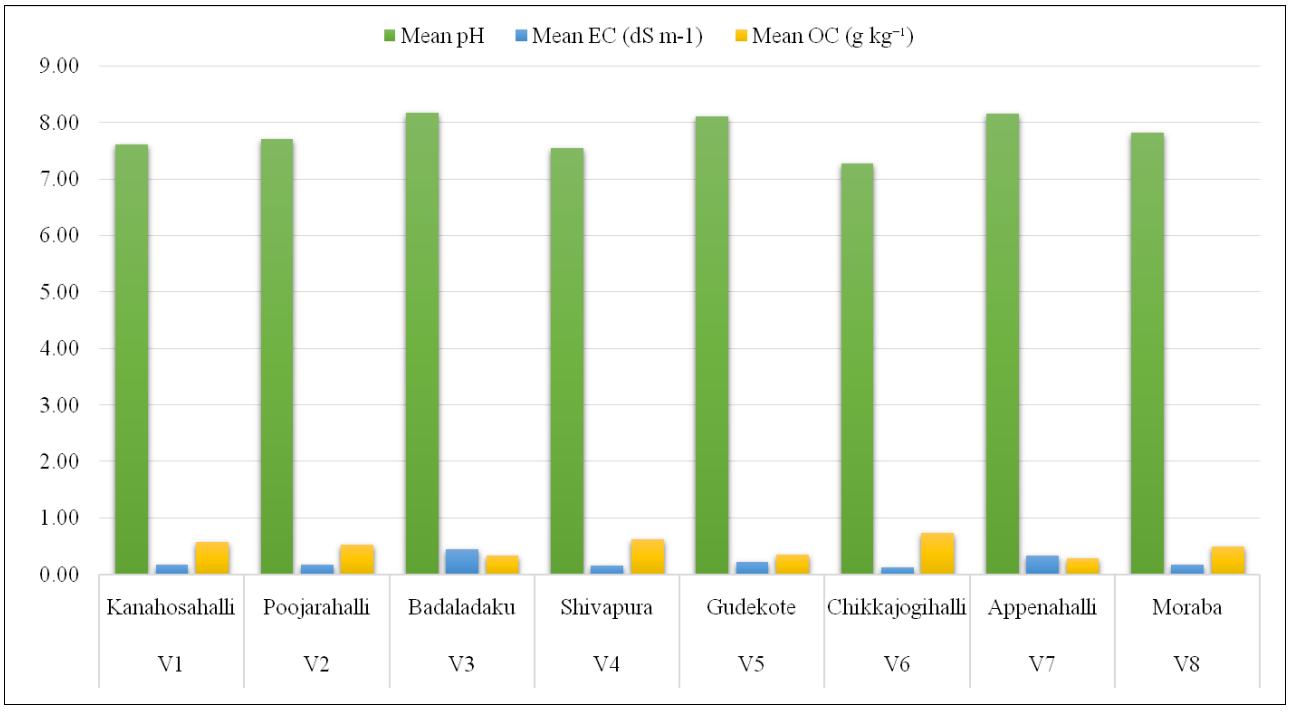


Fig 1: Mean pH, Mean EC and Mean Organic carbon

3. Available phosphorus and potassium

Available phosphorus, expressed as P_2O_5, ranged from 15.65 to 35.97 kg ha^{-1}, with a mean of 26.07 kg ha^{-1}. Chikkajogihalli (V_6S_1) recorded the minimum, while Badaladaku (V_3S_1) recorded the maximum (Table 1). Differences in phosphatic fertilizer application, organic inputs, phosphorus fixation and crop removal may account for the observed variation.

The higher value at Badaladaku may be associated with past fertilizer or manure inputs, although management records would be needed to confirm this explanation. The lower value at Chikkajogihalli suggests that phosphorus availability deserves attention when planning nutrient application. Variation in phosphorus status in cultivated soils has also been reported by Jamuna *et al*. (2008) [3] and Selvaraj and Naidu (2012) [12].

Available potassium, expressed as K_2O, ranged from 127.65 to 385.26 kg ha^{-1}. The lowest value was recorded at Chikkajogihalli (V_6S_1), and the highest at Appenahalli (V_7S_5).

The thesis reports a mean of 167.58 kg ha^{-1}. Differences in potassium-bearing minerals, fertilizer inputs, crop removal and organic matter management may contribute to the spatial variation. The relatively high value at Appenahalli may reflect greater native potassium supply or nutrient replenishment, whereas the minimum at Chikkajogihalli indicates comparatively lower available potassium at that sampling point. Similar location-wise differences in soil potassium and other nutrients have been reported by Babu *et al*. (2002) [1], Pradeep *et al*. (2006) [9] and Jamuna *et al*. (2008) [3].

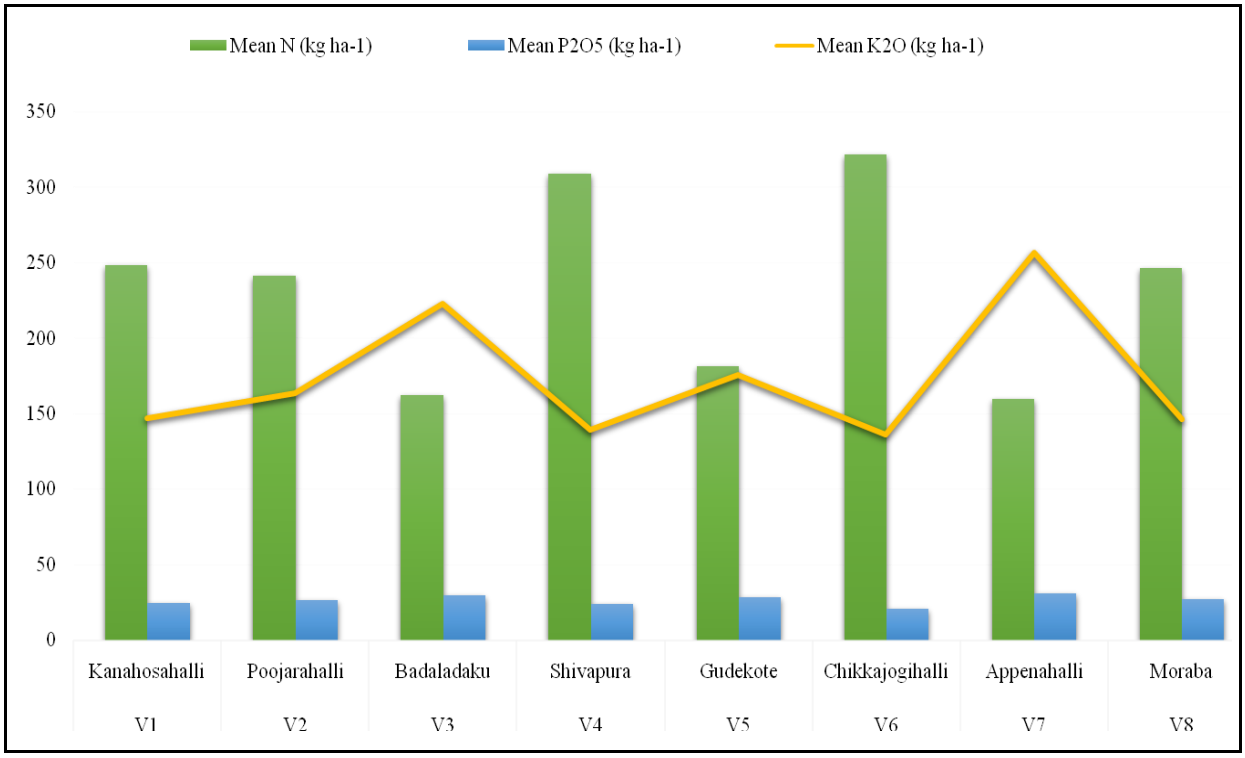


Fig. 2: Mean N (kg ha^{-1}), Mean P_2O_5 (kg ha^{-1}) and Mean K_2O (kg ha^{-1})

4. DTPA-extractable micronutrients

DTPA-extractable iron ranged from 7.31 to 34.48 mg kg^{-1}, with a mean of 22.33 mg kg^{-1}. The minimum was recorded at Badaladaku (V_3S_1), and the maximum at Kanahosahalli (V_1S_3). Variation in Fe may be associated with differences in iron-bearing minerals, soil reaction and organic matter. Despite alkaline conditions at some sites, the reported overall range indicates appreciable Fe availability in several samples. Similar differences in micronutrient status across cultivated soils were reported by Babu *et al*. (2002) [1] and Raj *et al*. (2006) [10].

DTPA-extractable manganese ranged from 2.10 to 23.80 mg kg^{-1}, with a mean of 9.87 mg kg^{-1}. The minimum was recorded at Badaladaku (V_3S_1), while the maximum was recorded at Kanahosahalli (V_1S_3). Differences in Mn-bearing minerals, organic carbon and soil reaction may explain some of the variation. Higher pH can reduce Mn availability, making soil reaction an important consideration when interpreting micronutrient status. Comparable location-related differences were reported by Babu *et al*. (2002) [1] and Raj *et al*. (2006) [10].

DTPA-extractable copper ranged from 1.02 to 2.76 mg kg^{-1}, with a mean of 1.64 mg kg^{-1}. Badaladaku (V_3S_1) recorded the minimum, whereas Chikkajogihalli (V_6S_1) recorded the maximum. The observed differences may be associated with soil properties, organic matter and the presence of Cu-bearing minerals. The thesis interpretation indicates that Cu was present in appreciable quantities in the study area. Variation in available Cu in cultivated soils has also been reported by Babu *et al*. (2002) [1] and Raj *et al*. (2006) [10].

Zinc showed the widest practical concern among the reported micronutrients: DTPA-extractable Zn ranged from 0.01 to 1.27 mg kg^{-1}, with a mean of 0.55 mg kg^{-1}. The minimum was recorded at Chikkajogihalli (V_6S_4), while the maximum was observed at Appenahalli (V_7S_1). The very low minimum indicates a potential zinc deficiency at particular sampling points. Soil pH, organic carbon, clay content and zinc fertilizer use may influence the available Zn pool; in particular, greater alkalinity can reduce zinc availability. Sravani (2015) similarly associated low available zinc in groundnut-growing soils with low organic matter and non-application of zinc fertilizer.

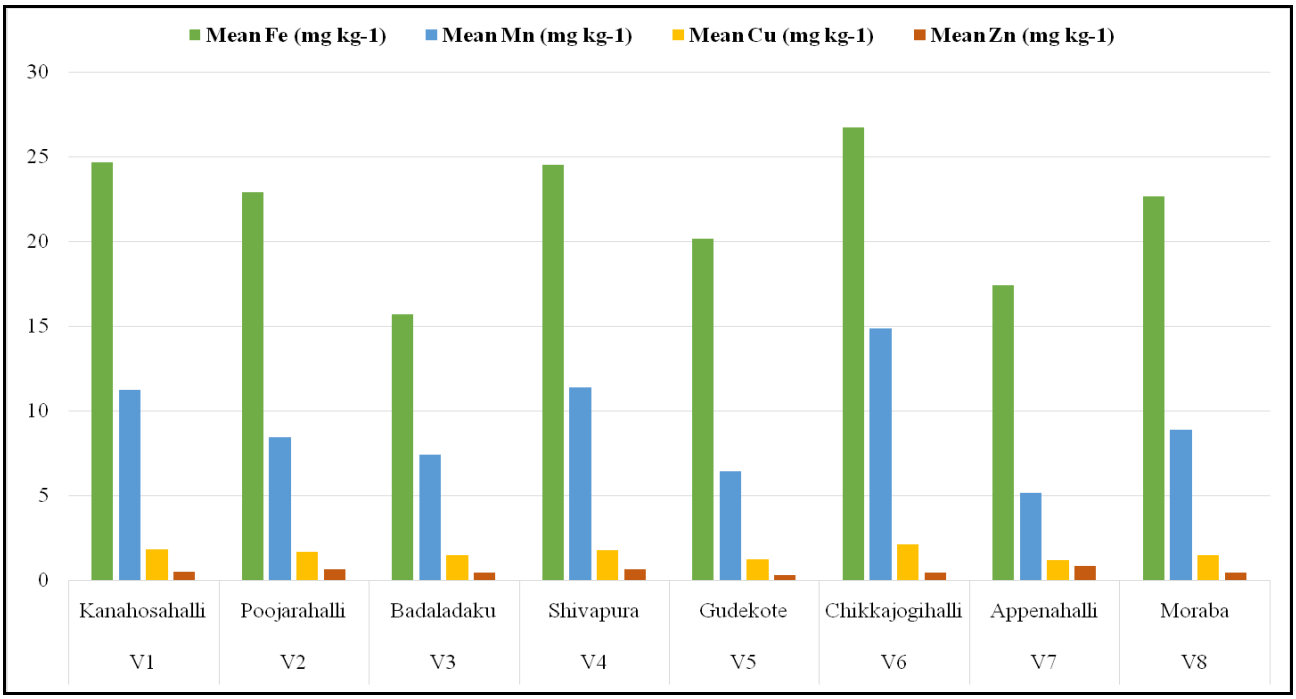


Fig 3: Mean Fe (kg ha^{-1}), Mean Mn (kg ha^{-1}), Mean Cu (kg ha^{-1}) and Mean Zn (kg ha^{-1})

Table 1: Range, mean and locations recording minimum and maximum values of soil properties

Soil property	Range	Mean	Minimum	Maximum
pH	6.43-8.68	7.75	Kanahosahalli (V_1S_3)	Badaladaku (V_3S_1)
EC (dS m^{-1})	0.05-0.86	0.20	Poojarahalli (V_2S_2)	Badaladaku (V_3S_1)
Organic carbon (%)	0.12-0.98	0.51	Badaladaku (V_3S_2)	Chikkajogihalli (V_6S_1)
Available N (kg ha^{-1})	100.26-390.51	238.59	Gudekote (V_5S_4)	Kanahosahalli (V_1S_6)
Available P_2O_5 (kg ha^{-1})	15.65-35.97	26.07	Chikkajogihalli (V_6S_1)	Badaladaku (V_3S_1)
Available K_2O (kg ha^{-1})	127.65-385.26	167.58	Chikkajogihalli (V_6S_1)	Appenahalli (V_7S_5)
DTPA-Fe (mg kg^{-1})	7.31-34.48	22.33	Badaladaku (V_3S_1)	Kanahosahalli (V_1S_3)
DTPA-Mn (mg kg^{-1})	2.10-23.80	9.87	Badaladaku (V_3S_1)	Kanahosahalli (V_1S_3)
DTPA-Cu (mg kg^{-1})	1.02-2.76	1.64	Badaladaku (V_3S_1)	Chikkajogihalli (V_6S_1)
DTPA-Zn (mg kg^{-1})	0.01-1.27	0.55	Chikkajogihalli (V_6S_4)	Appenahalli (V_7S_1)

5. Overall soil nutrient constraints and management implications

The results indicate that soil fertility varied among the eight villages. Three features are particularly relevant to groundnut production: (i) low organic carbon at some sampling points, (ii) low available nitrogen in part of the sampled area and (iii) very low available zinc at Chikkajogihalli (V_6S_4). The soils were generally non-saline, while pH varied from slightly acidic to alkaline. Available phosphorus, potassium and other micronutrients also differed among locations, indicating that a uniform fertilizer recommendation may not adequately address local nutrient requirements.

A practical response is to base fertilizer recommendations on soil-test results, improve organic matter through suitable farmyard manure and crop-residue management and apply zinc only where soil tests or crop diagnosis indicate a need. Balanced nutrient management, including appropriate organic inputs and biofertilizers. These measures should be adapted to the nutrient status of individual fields rather than applied uniformly across the taluk.

Conclusion

Assessment of 60 surface soil samples from eight groundnut growing villages of Kudligi taluk showed considerable spatial variation in soil nutrient status. Soil pH ranged from slightly acidic to alkaline, while low mean EC indicated that salinity was not a major constraint. Organic carbon and available nitrogen were low in some locations, and available P_2O_5 and K_2O differed substantially between sampling points. DTPA-extractable Fe, Mn and Cu also varied, while the very low Zn value at Chikkajogihalli indicated a potential zinc constraint. Soil-test-based nutrient management, improved organic matter inputs and location-specific correction of micronutrient deficiencies are therefore important for maintaining soil fertility and supporting sustainable groundnut cultivation in the study area.

Acknowledgement

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