

Original Research Article

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Effect of Soil Fertility Constraints based Nutrient Management on Growth, Yield and Quality Parameters of Groundnut (*Arachis hypogaea* L.) at Kurthkoti-2 Micro-watershed, Gadag

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ABSTRACT

A field experiment was conducted to study the effect of soil fertility constraints based nutrient management on groundnut (*Arachis hypogaea* L.) at Kurthkoti-2 micro-watershed, Gadag. The RCBD was imposed with ten treatments replicated thrice. The non-gravelly, clay textured black soils belong to *Typic Chromustert* with moderately alkaline pH having low to medium fertility status (N, P₂O₅, K₂O and S: 180, 20.5, 351 and 17.5 kg ha⁻¹) significantly responded in terms of groundnut growth and yield during *kharif* 2018. Soil application of 175 % RD N, P₂O + 75 % K₂O nutrients recorded the significantly higher growth parameters *i.e.* plant height (19.86, 35.00 and 45.80 cm), number of branches plant⁻¹ (5.74, 6.60 and 6.74) and dry matter per plant (6.78, 17.43 and 26.85 g) at different stages (30, 60 DAS and at harvest respectively) along with significant higher yield attributes *i.e.* number of pods plant⁻¹ (22.46), pod weight plant⁻¹ (11.62 g), shelling per cent (85.34 %) and test weight (41.66 g). Further the same treatment recorded significantly higher pod (2898 kg ha⁻¹) and haulm (3848 kg ha⁻¹) yield with an increase in the oil (44.67 %) and protein (22.20 %) contents in kernel.

Keywords

Groundnut,
Fertility constraints,
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Introduction

In rainfed locales of India, dilapidated soil fertility and nutrient imbalances are major issues influencing agricultural productivity. Organic matter levels have declined sharply in intensively cropped regions, prompting stale

yields of real sustenance of major food crops. Notwithstanding a widespread insufficiency of nitrogen (N), inadequacies of phosphorus (P), sulfur (S) and micronutrients are developing as imperatives for sustaining and additionally upgrading profitability under intensive crop production systems. It is evaluated that 29.4 m

ha of soils in India are encountering a decline in fertility with a net negative parity of 8 to 10 Mt of nutrients per year (Srinivasarao, 2011). Poor nutrient use efficiency is another reason for concern. So far, soil fertility issues have been addressed predominantly in irrigated agriculture, yet late examinations have shown that drylands are parched as well as ravenous.

In the ongoing past, the concept of watershed based functional relation between parts and the whole development has emerged as one of the potential holistic approaches in rainfed areas, prompting to higher productivity and sustainability in agriculture. Assessment of fertility status and nutrient mapping of soils are an integral part of the watershed, which is needed to identify the extent of soils deficient in nutrients for site-specific recommendations. Soil fertility maps generated by UAS Dharwad under the Sujala-III watershed project of Karnataka during 2017-18 are taken as base maps to locate fertility constraints. Equally essential is the redefinition of soil fertility assessment criteria in the light of altering crop production scenarios where financial yield response due to nutrient input are usually reported on soils categorized as 'medium' or 'elevated' fertility soils (Das *et al.*, 2015). Unless fertilizer application connotes soil-test based nutrient management, it is no longer 'balanced'. Unfortunately, actual field-based information on soil-test based nutrient management are scarce. The soil-test based nutrient management involving all deficient nutrients have been seldom attempted on cultivator's fields. So, there is, a pressing need to generate recommendations to gain sustained higher productivity and farm profit in the adverse climate. With this backdrop, a scientific look was initiated on an evaluation of multi-nutrient deficiencies in specific site and their redressal via graded levels of fertilizers on groundnut- the major crop of Northern dry zone-3 of Karnataka.

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Materials and Methods

As a part of the present investigation, the test crop groundnut (GPBD- 4) was grown during *Kharif* 2018 in the farm fields of KVK Hulkoti. The experimental site is situated near Kurthkoti village (Survey no. 321) belong to Gadag district of Karnataka with a latitude of 15°22'36'' N and a longitude of 75°31'43'' E which comes under Northern dry zone of Karnataka state (Fig. 1). The rainfall received in all the months during the crop growth period ranged from 34.39 mm (October) to 130.07 (June) mm. The experimental site is good cultivable land with runoff limitation due to drainage. It suits moderately (S2) for groundnut cultivation. Non-gravelly, very deep (>150 cm) clay textured black soils belong to *Typic Chromustert* (Fig. 2). A composite soil sample from 0-20 cm depth was collected from the experimental site before initiating the experiment and analyzed for chemical properties and fertility status. The results are presented in Table 1.

The soil fertility maps generated under SUJALA-III watershed project, UAS, Dharwad were taken as base maps to locate the soil fertility constraint for groundnut production. The maps implies that available nitrogen, phosphorus, boron and zinc were found deficient whereas sulphur and organic carbon were medium in range and potassium and iron were high in available status at the selected site (Survey no. 321) for the field experiment. Based on these facts the following modification in RDF was made. *i.e.* T₁: Control (RPP), T₂: 125 % RD N and P₂O₅ + 25 % K₂O, T₃: 125 % RD N and P₂O₅ + 50 % K₂O, T₄: 125 % RD N and P₂O₅ + 75 % K₂O, T₅: 150 % RD N and P₂O₅ + 25 % K₂O, T₆: 150 % RD N and P₂O₅ + 50 % K₂O, T₇: 150 % RD N and P₂O₅ + 75 % K₂O, T₈: 175 % RD N and P₂O₅ + 25 % K₂O, T₉: 175 % RD N and P₂O₅ + 50 % K₂O and T₁₀: 175 % RD N and P₂O₅ + 75 % K₂O. RPP is (25:50:25

N:P₂O₅:K₂O kg ha⁻¹ FYM @ 5 t ha⁻¹ + Gypsum 500 kg ha⁻¹ + 10 kg ha⁻¹ ZnSO₄ + 10 kg ha⁻¹ FeSO₄ + *Rhizobium* @ 1000 g ha⁻¹ + PSB @ 1000 g ha⁻¹) was common for all the treatments. The treatments were replicated thrice in Randomized Complete Block Design with plot dimensions 4.2 m × 4.4 m. The biometric observations were recorded at 30, 60 DAS and at maturity.

Shelling per cent was computed by (kernel weight/ pod weight) × 100. Oil content was estimated by Nuclear Magnetic Resonance (NMR, Oxford 4000). The oil yield per hectare was worked out by the formula (Oil content × Shelling per cent × Pod yield)/10⁴ and expressed in kg ha⁻¹.

The soil samples were processed and analyzed for pH (1:2.5), EC (1:2.5), OC by Walkley and Black's wet oxidation method (Sparks, 1996). Free CaCO₃, particle density and particle size distribution (Piper, 2002). Bulk density by clod method as described by Black (1965). Available nitrogen in the soil was determined by modified alkaline permanganate method of Subbiah and Asija (1956) as described by Sahrawat and Burford (1982). Available phosphorous, potassium and sulphur by NaHCO₃ extraction followed by spectrophotometry method, 1N Ammonium acetate extraction followed by flame photometric method and 0.1 N CaCl₂.2H₂O extraction followed by turbidimetry method respectively as described by Sparks (1996). Micronutrients (Fe and Zn) by DTPA extraction followed by atomic absorption spectrophotometer method as described by Lindsay and Norvell (1978).

The experimental data obtained were subjected to statistical analysis as described by Gomez and Gomez (1984). The level of significance used in 'F' test was P = 0.05. Critical differences were calculated wherever 'F' test was significant.

Results and Discussion

Growth parameters of groundnut (cf Table 2)

The significantly tallest plants were recorded in the treatment (T₁₀) which received soil application of 175 % RD N, P₂O₅ + 75 % K₂O (45.80 cm) compared to control and rest of the treatments, except the treatment (T₇) with soil application of 150 % RD N, P₂O₅ + 75 % K₂O (45.00 cm). Further, the treatment (T₆ and T₉) with soil application of 150 % RD N, P₂O₅ + 50 % K₂O and 175 % RD N, P₂O₅ + 50 % K₂O (43.66 and 43.26 cm) were on par with each other but significantly superior over control and the treatment composed of 125 % RD N and P₂O along with ascending rate of potassium application *i.e.* 25, 50 and 75 % RD K₂O (T₂, T₃ and T₄). The plant height of groundnut at 30 and 60 DAS ranged from 15.46 to 19.86 cm and 30.20 to 35.00 cm respectively and the effect of different treatments were similar with the observations made at harvest.

The significantly higher number of branches per plant *i.e.* 6.74 at harvest were recorded in the treatment (T₁₀) which received soil application of 175 % RD N, P₂O + 75 % K₂O and was on par with the treatments (T₇ and T₉) with the soil application 150 % RD N, P₂O₅ + 75 % K₂O and 175 % RD N, P₂O₅ + 50 % K₂O (6.70 and 6.26) but significantly superior over control and other treatments. Further, treatments (T₄ and T₃) with soil application of 125 % RD N, P₂O₅ + 75 % K₂O (6.06) and 125 % RD N, P₂O₅ + 50 % K₂O (5.94) were on par with each other but significantly superior over control.

Number branches per plant in groundnut at 30 DAS and 60 DAS ranged from 4.13 to 5.74 and 5.20 to 6.60 respectively. The effect of different treatments was similar to that observed at harvest and comparatively much

changes were not observed from 60 DAS to the harvest time with respect number of branches.

The total dry matter ranges from 20.82 to 26.85 g plant⁻¹ at harvest. The facts of experimental outcomes convince that, the significantly higher total dry matter (26.85 g plant⁻¹) was recorded in treatment (T₁₀) receiving 175 % RD N, P₂O₅ + 75 % K₂O at harvest. Next to superior, the treatment (T₇) composed of 150 % RD N, P₂O₅ + 75 % K₂O was yielded 26.24 g plant⁻¹, stand insignificant with the treatment T₈ but significant with rest. The total dry matter of groundnut at 30 DAS and 60 DAS ranges from 4.76 to 6.78 g plant⁻¹ and 14.83 to 17.43 g plant⁻¹. The growth trend

of groundnut among the different treatments at 30 DAS and 60 DAS has been recorded similar as at harvest. The increase in plant height, number of branches and total dry matter production at different growth stages might be due to the increased levels soil application of P. The development of extensive root system and nodulation, and thus enables plants to absorb more water and nutrients from varied depth of the soil with an indirect action of phosphorus element. This in turn could enhance the plant's ability to generate more assimilates which were reflected in the higher dry matter production. Similar results have been reported by El-Habbasha *et al.*, 2005 and Gobarah *et al.*, 2006.

Table.1 Initial physical and chemical properties of the soil of experimental site

Sl. No.	Parameters	Units	Values
A	Physical properties		
1	Particle size distribution (per cent oven dry basis)		
	Sand	%	21.65
	Silt		19.35
	Clay		59.00
2	Texture		Clay
3	Bulk density	Mg m ⁻³	1.28
4	Particle density		2.62
5	Pore space	%	51.14
B	Chemical properties		
1	Soil reaction (1:2.5)		8.4 (Moderately alkaline)
2	Electrical conductivity (1:2.5)	dS m ⁻¹	0.22 (Normal)
3	Free CaCO ₃ content	%	11.5 (Moderately calcareous)
4	Soil organic carbon	g kg ⁻¹	3.75 (Low)
C	Fertility status		
1	Available Nitrogen	kg ha ⁻¹	180 (Low)
2	Available Phosphorous		20.5 (Low)
3	Available Potassium		351 (High)
4	Available Sulphur		17.5 (Medium)
5	Available Zinc	mg kg ⁻¹	0.42 (Deficit)
6	Available Iron		4.8 (Sufficient)

Table.2 Effect of soil application of major nutrients on growth parameters of groundnut

Treatment details	Plant height (cm)			No. of branches plant ⁻¹			Total dry matter (g plant ⁻¹)		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
T₁: RPP (control)	15.46	30.20	40.13	4.13	5.20	5.20	4.76	14.83	20.82
T₂: 125 % RD N, P₂O₅ + 25 % K₂O	17.20	31.60	41.80	4.74	5.60	5.60	5.02	15.09	22.13
T₃: 125 % RD N, P₂O₅ + 50 % K₂O	17.66	31.73	42.33	5.20	5.80	5.94	5.36	15.47	22.72
T₄: 125 % RD N, P₂O₅ + 75 % K₂O	18.06	32.33	43.33	5.00	6.00	6.06	5.67	16.40	24.04
T₅: 150 % RD N, P₂O₅ + 25 % K₂O	18.46	33.86	42.26	5.40	6.00	6.12	5.78	16.55	24.53
T₆: 150 % RD N, P₂O₅ + 50 % K₂O	19.26	34.20	43.66	5.46	6.20	6.20	6.15	16.94	25.16
T₇: 150 % RD N, P₂O₅ + 75 % K₂O	19.80	34.66	45.00	5.66	6.54	6.70	6.60	17.28	26.24
T₈: 175 % RD N, P₂O₅ + 25 % K₂O	18.94	33.86	42.93	5.20	6.00	6.00	6.06	16.60	25.48
T₉: 175 % RD N, P₂O₅ + 50 % K₂O	19.34	34.26	43.26	5.54	6.20	6.26	6.18	16.94	25.94
T₁₀: 175 % RD N, P₂O₅ + 75 % K₂O	19.86	35.00	45.80	5.74	6.60	6.74	6.78	17.43	26.85
S.Em±	0.15	0.21	0.36	0.16	0.11	0.10	0.07	0.10	0.15
CD (0.05)	0.49	0.69	1.18	0.52	0.35	0.34	0.23	0.33	0.49
CV (%)	7.45	6.12	8.48	5.42	4.21	4.04	8.77	10.11	10.95

RPP: Recommended Package of Practice (25: 50: 25 N: P₂O₅: K₂O kg ha⁻¹ FYM @ 5 t ha⁻¹ + Gypsum 500 kg ha⁻¹ + 10 kg ha⁻¹ ZnSO₄ + 10 kg ha⁻¹ FeSO₄ + *Rhizobium* @ 1000 g ha⁻¹ + PSB @ 1000 g ha⁻¹)

Foliar spray of boron 1.25 g L⁻¹ was applied 30 DAS for all the treatments

RPP is common for all the treatments

DAS – Days after sowing

Table.3 Effect of soil application of major nutrients on yield parameters of groundnut

Treatment details	No. of pods plant ⁻¹	Pod wt. plant ⁻¹	Shelling per cent	Test weight
		(g)	(%)	(g)
T₁: RPP (control)	18.40	08.32	71.75	35.30
T₂: 125 % RD N, P₂O₅ + 25 % K₂O	19.86	09.29	72.56	36.70
T₃: 125 % RD N, P₂O₅ + 50 % K₂O	20.60	09.54	72.90	36.42
T₄: 125 % RD N, P₂O₅ + 75 % K₂O	21.26	10.21	73.25	37.90
T₅: 150 % RD N, P₂O₅ + 25 % K₂O	21.60	10.66	73.52	39.15
T₆: 150 % RD N, P₂O₅ + 50 % K₂O	21.86	10.96	74.21	39.80
T₇: 150 % RD N, P₂O₅ + 75 % K₂O	21.73	11.28	75.18	41.50
T₈: 175 % RD N, P₂O₅ + 25 % K₂O	22.13	10.72	72.87	38.10
T₉: 175 % RD N, P₂O₅ + 50 % K₂O	22.26	10.94	74.64	39.26
T₁₀: 175 % RD N, P₂O₅ + 75 % K₂O	22.46	11.62	75.34	41.66
S.Em±	0.23	0.06	0.23	0.27
CD (0.05)	0.74	0.20	0.73	0.87
CV (%)	7.01	6.62	4.32	5.22

RPP: Recommended Package of Practice (25: 50: 25 N: P₂O₅: K₂O kg ha⁻¹ FYM @ 5 t ha⁻¹ + Gypsum 500 kg ha⁻¹ + 10 kg ha⁻¹ ZnSO₄ + 10 kg ha⁻¹ FeSO₄ + *Rhizobium* @ 1000 g ha⁻¹ + PSB @ 1000 g ha⁻¹)

Foliar spray of boron 1.25 g L⁻¹ was applied 30 DAS for all the treatments

RPP is common for all the treatments

TDM – Total dry matter

Test weight : 100 kernel weight

Table.4 Effect of soil application of major nutrients on yield of groundnut

Treatment details	Pod yield	Kernel yield	Haulm yield	TDM
	(kg ha ⁻¹)			
T₁: RPP (control)	2104	1510	3156	5260
T₂: 125 % RD N, P₂O₅ + 25 % K₂O	2349	1704	3244	5593
T₃: 125 % RD N, P₂O₅ + 50 % K₂O	2412	1758	3330	5742
T₄: 125 % RD N, P₂O₅ + 75 % K₂O	2582	1891	3493	6075
T₅: 150 % RD N, P₂O₅ + 25 % K₂O	2696	1982	3522	6218
T₆: 150 % RD N, P₂O₅ + 50 % K₂O	2772	2057	3586	6358
T₇: 150 % RD N, P₂O₅ + 75 % K₂O	2851	2148	3780	6631
T₈: 175 % RD N, P₂O₅ + 25 % K₂O	2711	1975	3713	6424
T₉: 175 % RD N, P₂O₅ + 50 % K₂O	2766	2064	3790	6556
T₁₀: 175 % RD N, P₂O₅ + 75 % K₂O	2898	2209	3848	6746
S.Em±	16.29	14.14	22.23	38.52
CD (0.05)	52.11	45.24	71.12	123.22
CV (%)	7.94	7.26	10.86	10.80

RPP: Recommended Package of Practice (25: 50: 25 N: P₂O₅: K₂O kg ha⁻¹ FYM @ 5 t ha⁻¹ + Gypsum 500 kg ha⁻¹ + 10 kg ha⁻¹ ZnSO₄ + 10 kg ha⁻¹ FeSO₄ + *Rhizobium* @ 1000 g ha⁻¹ + PSB @ 1000 g ha⁻¹)

Foliar spray of boron 1.25 g L⁻¹ was applied 30 DAS for all the treatments

RPP is common for all the treatments

TDM – Total dry matter

Table.5 Effect of soil application of major nutrients on quality parameters of groundnut

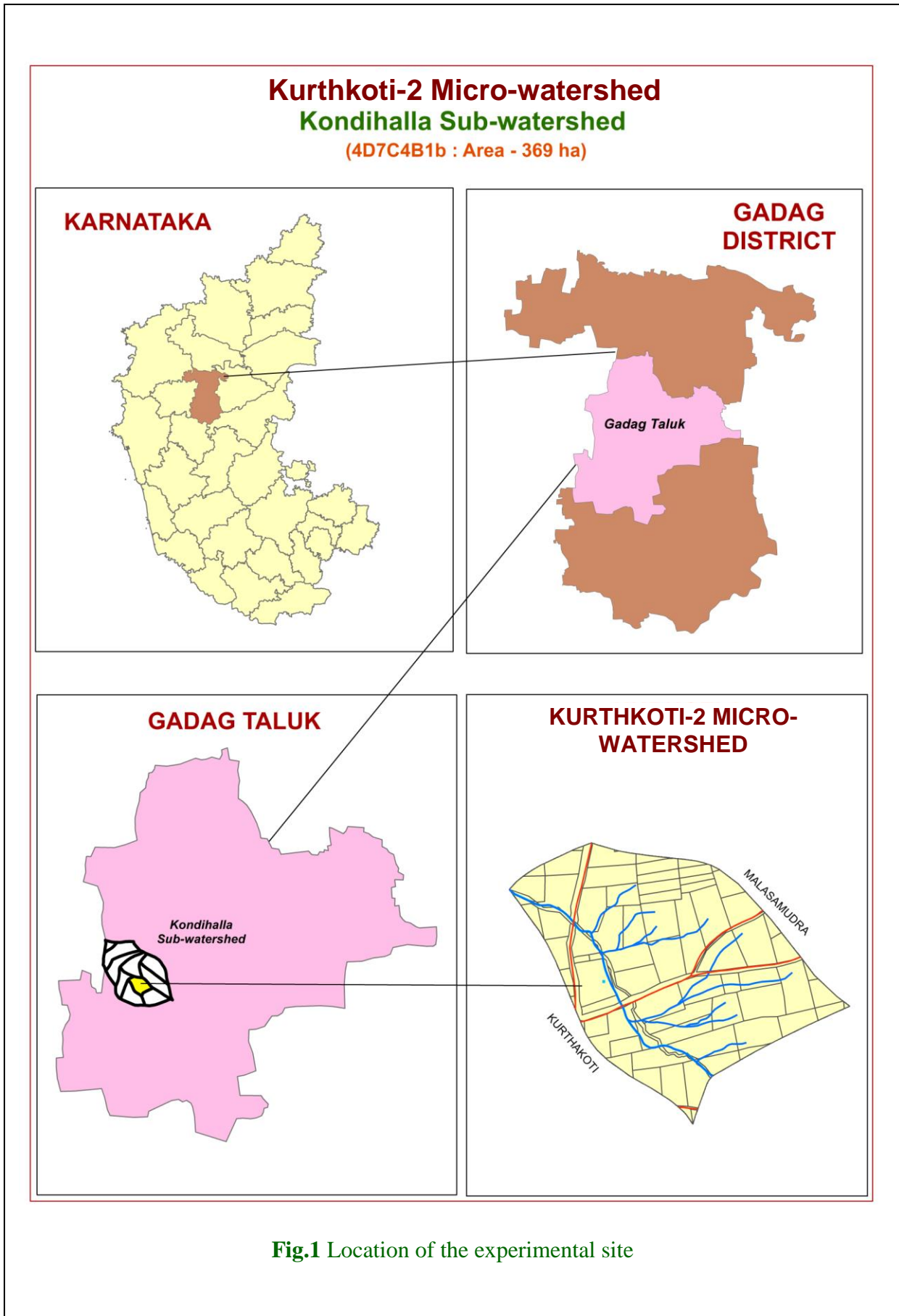
Treatment details	Oil content (%)	Oil yield (kg ha ⁻¹)	N conc. in kernel (%)	*Crude protein content (%)
T₁: RPP (control)	43.48	656	3.08	19.25
T₂: 125 % RD N, P₂O₅ + 25 % K₂O	43.25	737	3.09	19.31
T₃: 125 % RD N, P₂O₅ + 50 % K₂O	43.49	764	3.12	19.52
T₄: 125 % RD N, P₂O₅ + 75 % K₂O	43.53	823	3.14	19.64
T₅: 150 % RD N, P₂O₅ + 25 % K₂O	44.07	873	3.20	20.02
T₆: 150 % RD N, P₂O₅ + 50 % K₂O	44.51	915	3.24	20.27
T₇: 150 % RD N, P₂O₅ + 75 % K₂O	44.63	958	3.32	20.79
T₈: 175 % RD N, P₂O₅ + 25 % K₂O	44.18	872	3.44	21.50
T₉: 175 % RD N, P₂O₅ + 50 % K₂O	44.59	920	3.48	21.77
T₁₀: 175 % RD N, P₂O₅ + 75 % K₂O	44.67	986	3.55	22.20
S.Em±	0.11	6.27	0.02	0.16
CD (0.05)	0.35	20.08	0.08	0.51
CV (%)	2.65	1.27	1.37	1.37

RPP: Recommended Package of Practice (25: 50: 25 N: P₂O₅; K₂O kg ha⁻¹ FYM @ 5 t ha⁻¹ + Gypsum 500 kg ha⁻¹ + 10 kg ha⁻¹ ZnSO₄ + 10 kg ha⁻¹ FeSO₄ + *Rhizobium* @ 1000 g ha⁻¹ + PSB @ 1000 g ha⁻¹)

Foliar spray of boron 1.25 g L⁻¹ was applied 30 DAS for all the treatments

RPP is common for all the treatments

* Crude protein content: N conc. in kernel (%) × 6.25



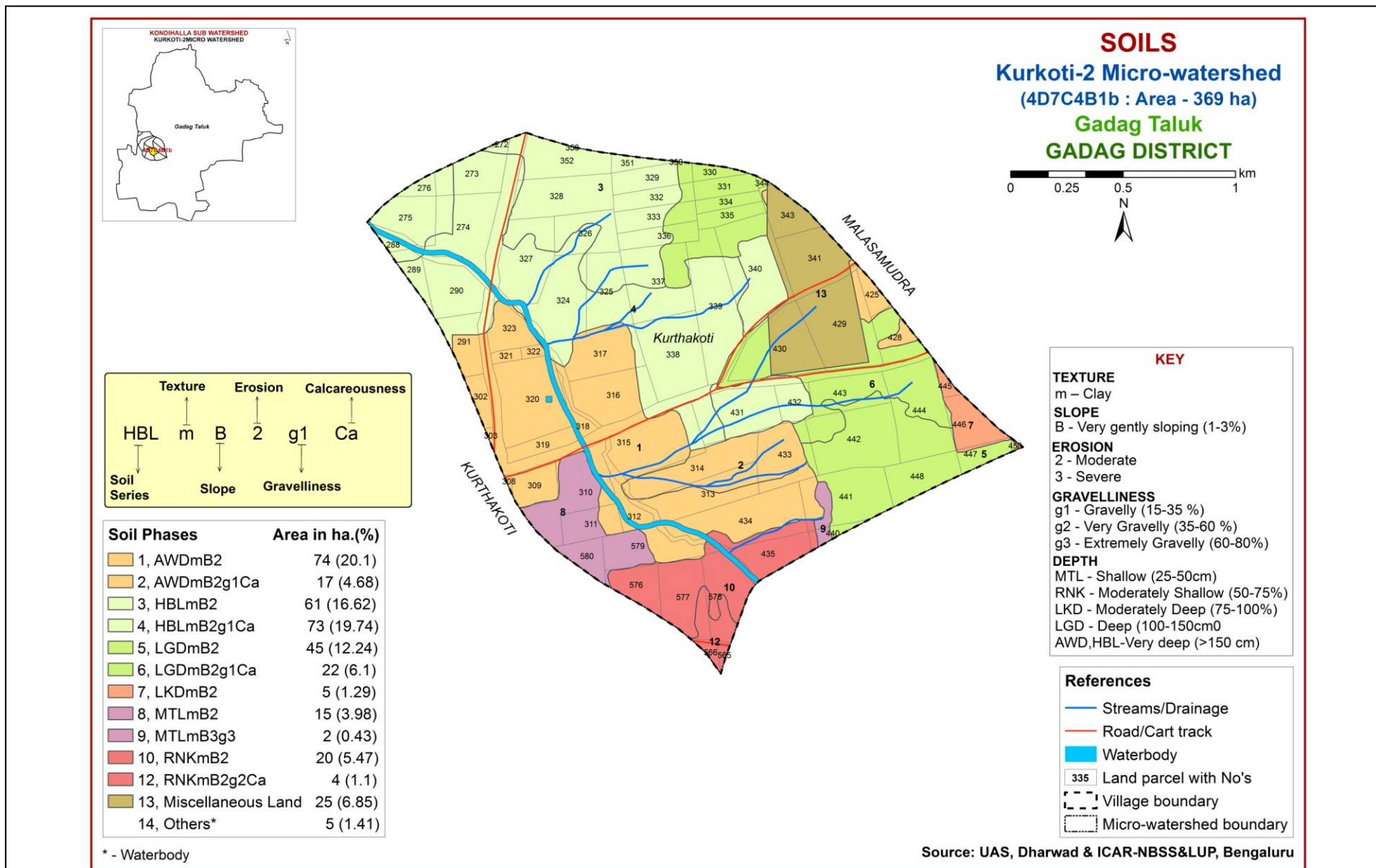


Fig.2 Soil characteristics at experimentation site

Yield attributes (cf Table 3)

The number of pods per plant ranged from 18.40 to 22.46 and significantly influenced due to the soil application of major nutrients at varied levels. The significantly more number of pods per plant were recorded in the treatment (T₁₀) which received soil application of 175 % RD N, P₂O₅ + 75 % K₂O (22.46) compared to control and rest of the treatments except the treatments (T₉, T₈ and T₇) with soil application of 175 % RD N, P₂O₅ + 50 % K₂O, 175 % RD N, P₂O₅ + 25 % K₂O and 150 % RD N, P₂O₅ + 75 % K₂O (22.26, 22.13 and 21.85) nutrients. Further, the pod weight ranged from 8.32 to 11.62 g plant⁻¹ and the significantly higher pod weight plant⁻¹ (11.62 g plant⁻¹) was recorded in treatment (T₁₀) receiving 175 % RD N, P₂O₅ + 75 % K₂O at harvest. Next to superior, the treatment (T₇) composed of 150 % RD N, P₂O₅ + 75 % K₂O was yielded 11.28 g plant⁻¹, stands insignificant with the treatment T₁₀ but significant with rest of treatments. The significantly maximum shelling per cent was recorded in the treatment (T₁₀) which received soil application of 175 % RD N, P₂O₅ + 75 % K₂O (75.34 %) compared to control and rest of the treatments except the treatments (T₇ and T₉) with soil application of 150 % RD N, P₂O₅ + 75 % K₂O and 175 % RD N, P₂O₅ + 50 % K₂O (75.18 and 74.64 %).

The test weight of 100 kernels was ranged from 35.30 to 41.66 g. The data revealed that the maximum test weight *i.e.* 41.66 g was recorded in the treatment (T₁₀) which received soil application of 175 % RD N, P₂O₅ + 75 % K₂O and was on par with the treatment (T₇) with the soil application 150 % RD N, P₂O₅ + 75 % K₂O (41.50 g) but significantly superior over control and other treatments. The increase in yield due to increased dose of P fertilizer may be attributed to the activation of metabolic processes, where its role in building phospholipids and nucleic acid is known. The pronounced dose of N resulted in development

and maintenance of chlorophyll and photosynthetic area in terms of leaf area index which in turn attributed to higher photosynthetic rate. In addition, an element K responsible for mobility would account for maximum translocation of photosynthates from leaves to the developing pods *i.e.* source to sink movement. Certainly this combination leads to more pods to gynophores ratio and ultimately higher pod yield.

Hence, the additional 50 per cent nitrogen in combination with 25 per cent deficit potassium recorded significantly higher pod yield compared to control that received only RDF. The results were proximal to the findings of Balasubramanian and Palaniappan (1996).

Yield (cf Table 4)

The pod yield ranged from 2104 to 2898 kg ha⁻¹. The maximum pod yield *i.e.* 2898 kg ha⁻¹ was recorded in the treatment (T₁₀) which received soil application of 175 % RD N, P₂O₅ + 75 % K₂O and was on par with the treatment (T₇) with the soil application 150 % RD N, P₂O₅ + 75 % K₂O (2851 kg ha⁻¹) but significantly superior over control and other treatments. Further, treatments (T₉ and T₈) with soil application of 175 % RD N, P₂O₅ + 50 % K₂O (2766 kg ha⁻¹) and 175 % RD N, P₂O₅ + 25 % K₂O (2711 kg ha⁻¹) were statistically on par with each other but significantly superior over the control. The rest treatments were statistically significant with each other and over the control. Similarly, the kernel yield as product of pod yield and shelling per cent do followed congruent trend with respect to yield. The haulm yield ranged from 3156 to 3848 kg ha⁻¹. The significantly maximum haulm yield (3848 kg ha⁻¹) was recorded in the treatment composed of 175 % RD N, P₂O + 75 % K₂O nutrients and was on par with the treatments (T₉ and T₇) with the soil application 175 % RD

N, P₂O₅ + 50 % K₂O and 150 % RD N, P₂O₅ + 75 % K₂O (3790 and 3780 kg ha⁻¹) but significantly superior over control and other treatments.

Yield being a complex character, is the sum of many morphological and biological events that occur during the crop growth and development (Thorave and Dhonde, 2007). The improvement in yield attributing parameters in groundnut might be correlated to the better establishment, improvement in the availability of plant nutrients and efficient translocation of photosynthates. This work is in conformity with Muralidharan *et al.*, (2002) in sugarcane and Nandakumar *et al.*, (2004) in rice.

Quality attributes (cf Table 5)

The oil content in groundnut kernels ranged from 43.25 to 44.67 per cent and the significantly maximum oil content *i.e.* 44.67 per cent was recorded in the treatment (T₁₀) which received soil application of 175 % RD N, P₂O + 75 % K₂O and was on par with the treatment (T₇, T₉ and T₆) with the soil application 150 % RD N, P₂O₅ + 75 % K₂O, 175 % RD N, P₂O₅ + 50 % K₂O and 150 % RD N, P₂O₅ + 50 % K₂O (44.63, 44.59 and 44.51 %) but significantly superior over control and other treatments.

The treatments composed of 125 % RD N and P₂O₅ were statistically insignificant irrespective of K₂O doses but significant over the control. Further, the oil yield ranged from 656 to 986 kg ha⁻¹ which was product of oil content, shelling per cent and pod yield. There will more pronounced effect of P on S uptake compared with effect S on P uptake due to the fact that PO₄²⁻ ions being a strong competitor for adsorption sites, causing desorption of SO₄²⁻ and consequently increasing S mobility. Similar results are recorded in Chandra and Khaldelwal (2009) who reported increased uptake of P and S in chickpea.

The significantly maximum crude protein content was recorded in the treatment which received 175 % RD N, P₂O + 75 % K₂O (22.20 %) and least was recorded in control that received purely RPP (19.25 %). Further the treatment (T₉) 175 % RD N, P₂O₅ + 50 % K₂O (21.77 %) was on par with T₁₀ and significant over the control. Crude protein content being dependent factor on N concentration in kernel made significant difference among the graded doses of soil application nitrogenous fertilizers.

Soil application of 175 % RD N, P₂O + 75 % K₂O nutrients resulted in significantly higher pod yield of 2898 kg ha⁻¹ with an increase in the oil (44.67 %) and protein (22.20 %) contents in kernel. However, the treatment composed of 150 % RD N, P₂O + 75 % K₂O was found be on par with many yield parameters can be recommended in similar fertility constraints areas.

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