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Crop suitability assessment of ground nut in Ponnaniyar basin soils of Tiruchirapalli, Tamil Nadu, India

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Abstract
Crop suitability was assessed in five pedons for their suitability to ground nut on the basis of variation in physiography, parent materials, and soil nutrients in Ponnaniyar basin soils of Tiruchirapalli, Tamil Nadu. The pedons were developed by non-calcareous gneiss with feldspar (P1), granite and feldspar intermingled in pedon 2, weathered gneiss (P3), weathered quartz and felspatic gneiss (P4) and gneiss with lime parent materials (P5) and classified as Vertisol (P3, P5), Inceptisol (P1, P2) and Alfisol (P4). In general, sand, silt and clay contents ranged from 16.00 to 71.55, 8.95 to 49.50 and 12.35 to 55.25% in different horizons, respectively. The soils were calcareous and moderately alkaline to strongly alkaline in reaction. The organic carbon ranged from 0.13 to 0.39 g kg^{-1} and cation exchange capacity from 16.23 to 19.91 cmol (p^{+}) kg^{-1} soil. The soils were low, medium and high in available N, P and K respectively. All five pedons are moderately suitable (S_1) for Ground nut cultivation, except Eliyattur series, it showed temporarily not suitable (N_1) category.

Keywords: Ground nut, soil nutrient status, pedon characteristics

Introduction
Ponnaniyar reservoir basin is situated in Mugavanur village of Manapparai taluk in Trichy district of Tamil Nadu. The amount of annual rainfall was diminished from 747.7 mm in 1986 to 444.6 mm in 2016. At the time of water scarcity, farmers from the village were tried for alternate crops in order to mitigate the water stress, many times they failed due to improper selection of crops. The better crop selection based on soil physical, chemical and physico-chemical properties enhance the crop productivity and help the farmers to get profitable income at the time of limited water availability due to climate change.
Ground nut is commonly known Peanut in India and is the most important oil seed as well as food crop. The ability of ground nut to produce high economic yields under soil moisture deficit makes it an important crop in rainfed and dryland agriculture. Ground nut also had an excellent nutritional value in view of their good protein content as well as oil content and better amino acid profile.

Materials and Methods
The study area lies between 10.59688 to 10.61374° N latitude and 78.268288 to 78.303818° E longitude ranging from 213 to 230 m above mean sea level with an area of 1830 acres of agricultural land. The average rainfall received is 787 mm per year with maximum rainfall during the North-East monsoon season and also a fair amount of rainfall during summer. The geology of the study area comprises of granite and gneiss. The soil moisture and soil temperature regimes of the study area are ustic and isohyperthermic, respectively. Five major soil series covering 1830 acres viz., Kunnattur, Eliyattur, Manapparai, Tiruchengode and Pilamedu were identified for the pedological investigations. The horizon-wise soil samples were collected processed and analysed for pH, electrical conductivity(EC), particle size distribution, organic carbon (OC), moisture retention, exchangeable cations, macronutrients pursuing standard analytical procedures (piper 1966; Richards 1954; Jackson 1973, 1979; Olsen 1965; Standford and English 1949; Subbiah and Asija 1956) [7, 9, 3, 5, 14, 15]. And classified according to Soil Taxonomy (Soil Survey Staff 2006) [13]. The pedons were evaluated for their suitability as per the criteria given by NBSS & LUP.

Results and Discussion

In Kunnatur soil series, the moist soil spectral colour varied from dark reddish brown 5YR 3/3 to reddish brown 5YR 4/4. Eliyattur soil series got the colour variations from reddish brown 5YR 4/4 to yellowish red 5YR 4/6. Tiruchengodu and Pilamedu soil series had similar colour in all the horizons i.e., very dark grey 10YR 3/1. In Manapparai soil series, the colour varied from reddish brown 2.5YR 9/4 to Red 10 R 9/6. The variation in colour among the soils studied may be ascribed to difference in organic matter content and chemical composition of soils (Sawhney *et al.,* 2005) [11]. The depth of soils ranged from shallow (<35 cm) to very deep (>150 cm). Soil depth was shallow in steep slope whereas deep soils were found in nearly level to very gently sloping plain. The same types of observations were reported by Meena *et al.* (2009) [4]. The bulk density of different horizons in five pedons varied from 1.34 to 1.59 Mg m^{-3}. The highest value of 1.59 Mg m^{-3} and lowest value of 1.34 Mg m^{-3} were noticed in Bt_4 and Ap horizons of Manapparai soil series. All the pedons showed increasing trend with depth except Kunnatur soil series. High bulk density values in the subsurface could be ascribed to decreased organic matter and secondary accumulation of illuviated clays in pore space. This was in line with the findings of Ram *et al.* (2010) [8]. The decrease in the porosity with depth in all soil series is due to increase in coarse fraction in Inceptisols and Entisols and filling up of pores by eluvial materials in Alfisol was reported by Walia and Rao, (1996) [17]. The percentage of water available under field capacity (33 kPa) varied from 10.69 to 24.79 per cent. The available water holding capacity of soils was found to vary from 1.30 to 11.34 per cent in Pilamedu soil series and Manapparai soil series respectively. Except Eliyattur and Tiruchengodu soil series, all the pedons exhibit increasing trend with soil depth. The moisture content of soil at different tensions depends on the quantity and quality of clay and the moisture holding capacity of soil. These are in accordance with the findings of Saravanan *et al.* (2000) [10]. The clay content of the soils were ranged from 12.35 to 55.25 percent. Except Eliyattur and Tiruchengodu soil series, all other pedons exhibit increasing trend in clay content with depth. The decrease in clay content with depth was observed in Tiruchengodu soil series, this might be due to variability of weathering in different horizons. These results were in accordance with the findings of Giri Prakash (1997) [2]. who reported an irregular decrease of clay content with depth in soils of Gudiyatham taluk in Tamil Nadu.

Table 1: Physical properties of soil

Pedon No.	Name of soil series	Horizon	Depth (cm)	Bulk density Mg m^{-3}	Porosity (%)	FC (%) at 33 kPa	PWP (%) at 1500 kPa	Particle size distribution (%)		
								Sand	Silt	Clay
1	Kunnatur	A_P	0-13	1.41	50.0	10.83	6.00	64	15	16
		$2A_1$	13-40	1.35	45.2	13.76	8.67	53	13.25	26.5
		B_S	40-55	1.38	40.8	13.90	8.14	47	16	31
		C_r	Non calcareous gneiss with feldspar loamy mixed isohyperthermic Typic Haplustepts							
2	Eliyattur	A_P	0-6	1.35	52.6	11.58	8.10	60	13	26.50
		AB	6-21	1.38	52.9	14.25	9.15	55	15.25	28.55
		CB	21-35	1.48	50.0	14.87	9.91	71.55	8.95	12.85
		C_r	Granite and feldspar intermingled loamy mixed isohyperthermic Typic Haplustepts							
3	Tiruchengodu	A_P	0-14	1.35	41.2	22.74	15.81	18	45	35.25
		B_C	14-150	1.51	33.5	20.81	19.07	17.25	49.50	30.95
		C_r	Weathered gneiss Fine mixed isohyperthermic Typic Calciusterts							
4	Manapparai	A_P	0-8	1.34	52.6	21.11	16.45	70.90	9.85	12.35
		Bt_1	8-38	1.42	41.6	14.73	9.43	68.90	11.25	13.65
		Bt_2	38-76	1.45	38.1	10.69	5.75	58	18	23
		Bt_3	76-84	1.58	37.6	13.07	7.60	56	17.25	21.85
		Bt_4	84-100	1.59	37.0	24.79	13.45	54.95	18.25	26.05
		C_r	Weathered quartz and feldspatic gneiss Fine mixed isohyperthermic Typic Haplustalfs							
5	Pilamedu	A_P	0-4	1.38	44.2	20.94	19.64	18.25	45.50	26.25
		B_1	4-35	1.45	40.1	23.54	15.94	30.90	26.55	39.35
		B_{SS1}	35-95	1.51	37.2	23.89	15.01	16	25.30	55.25
		C_K	Gneiss with lime Fine mixed isohyperthermic Typic Calciusterts							

The slit content of the soilsvaried from 8.95 to 49.50 percent. The sand content of the soils were ranged from 16 percent to 71.55 percent. Eliyattur soil series registered maximum amount of sand in CB (subsurface) horizon and Bss_1 (subsurface) horizon of Pilamedu soil series recorded minimum amount of sandfraction. All the pedons more or less follows the decreasing trend with depth (Table 1).

The pH of 1: 2.5 soil water suspension ranged from 7.15 to 8.98 indicating neutral to moderately alkaline, in reaction. Eliyattur, Tiruchengodu and Pilamedu soil series exhibit decreasing trend with depth. The remaining pedons did not show any particular trend with depth. The electrical conductivity of 1: 2.5 soil water suspension varied from 0.10 to 0.28 dS m^{-1}. The maximum value of 0.28 dS m^{-1} was recorded in Apsurface) horizon of Pilamedu soil series, whereas the minimum electrical conductivity of 0.10 dS m^{-1} was noticed in Bss_1(subsurface) horizon of Pilamedu soil series and Bt_4 (subsurface) horizon of Manapparai soil series. Tiruchengodu and Pilamedu soil series showeddecreasing trend with depth and the remaining pedons did not show any particular trend with depth. The soil organic carbon ranged from 0.13 to 0.39 per cent (Table 2). All the five soil series recorded low organic carbon status invariably. The low organic carbon might be due to erosion, leaching and rapid oxidation of organic matter under isohyperthermic regime prevailing in the area. These findings are in line with that of Singh and Agarwal (2005). Similar findings in line with Vertisols, Inceptisols and Alfisols were also reported by Vijayakumar *et al.* (1994) [16]. The per cent base saturation on the exchange complex varied from 96.98 (Bt_1) to 99.47 (Bt_2) percent in Manapparai soil series. Eliyattur and Tiruchengodu soil series exhibited a decreasing trend with depth and the remaining pedons showed an irregular trend with depth. The available nitrogen content of the Ponnaniyar basin soils were

ranged from 51.0 to 92.2 kg ha^{-1}. In Ponnaniyar basin, 100 per cent of the surface soil sample recorded low in available nitrogen. The available phosphorus content of Ponnanaiyar reservoir soils were ranged from 9.7 kg ha^{-1} to 33 kg ha^{-1}. Paramasivan (1992) [6]. Was also reported that phosphorus status was medium in Kangayampalayam and Koduveri series in lower Bhavani project command area. The available potassium content of Ponnaniyar reservoir basin soils were ranged from 195 to 799 kgha^{-1} (Table 2). The relatively higher content of available K was due to prevalence of K rich minerals like feldspar, muscovite mica, biotite mica and secondary minerals such as illite, vermiculite, weathered mica and smectite in these soils (Singh *et al.*, 2006) [12].

Table 2: Chemical properties and available nutrient status of soil

Pedon No.	Horizon	Depth (cm)	pH	EC (dS m^{-1})	OC (%)	Available macronutrients (Kg ha^{-1})					
						N		P		K	
						Range	Mean	Range	Mean	Range	Mean
1	A_P	0-13	7.28	0.14	0.20	51.0-92.2	70.7	9.7-33.0	14.4	195-799	555
	$2A_1$	13-40	7.15	0.13	0.18						
	B_S	40-55	7.52	0.15	0.14						
	C_r	Non calcareous gneiss with feldspar									
2	A_P	0-6	7.74	0.17	0.17	54.0-91.7	71.1	10.1-32.0	14.2	197-805	557
	AB	6-21	7.65	0.13	0.14						
	BC	21-35	7.22	0.19	0.13						
	C_r	Granite and feldspar intermingled									
3	A_P	0-14	8.81	0.17	0.36	51.2-93.0	70.8	10.0-31.0	14.0	194-809	556
	B_C	14-150	8.48	0.14	0.30						
	C_r	Weathered gneiss									
4	A_P	0-8	7.55	0.14	0.24	50.7-92.3	70.6	9.9-32.0	14.0	200-800	559
	Bt_1	8-38	7.27	0.15	0.19						
	Bt_2	38-76	7.30	0.13	0.18						
	Bt_3	76-84	7.32	0.15	0.18						
	Bt_4	84-100	7.36	0.10	0.14						
	C_r	Weathered quartz and feldspatic gneiss									
5	A_P	0-4	8.98	0.28	0.39	55.2-90.8	70.5	9.4-30.5	13.9	197-798	553
	B_1	4-35	8.65	0.19	0.29						
	B_{SS1}	35-95	8.04	0.10	0.20						
	C_K	Gneiss with lime									

Table 3: Exchangeable properties of soil

Pedon No.	Name of series	Horizon	Ca	Mg	Na	K	CEC	ESP (%)	BSP (%)
			(cmol(p+)kg^{-1})						
1	Kunnatur	A_P	10.0	4.00	1.7	0.70	16.60	10.2	98.80
		$2A_1$	11.0	4.22	1.8	0.50	17.80	10.1	98.43
		B_S	11.0	3.20	2.1	0.64	17.10	12.3	99.06
2	Eliyatur	A_P	9.7	6.00	2.2	0.40	18.50	11.9	98.92
		AB	8.9	5.00	2.1	0.20	16.40	12.8	98.78
		BC	10.2	3.80	1.5	0.60	16.50	9.1	97.58
3	Tiruchengodu	A_P	9.5	5.20	3.93	0.51	19.32	20.3	99.07
		B_C	10.89	4.65	3.1	0.50	19.33	16.0	99.02
4	Manapparai	A_P	9.4	4.30	1.7	0.60	16.23	10.5	98.58
		Bt_1	10.5	3.90	2	0.42	16.91	11.8	99.47
		Bt_2	10.2	6.30	1.9	0.54	19.53	9.7	96.98
		Bt_3	10.5	6.10	1.8	0.50	19.10	9.4	98.95
		Bt_4	9.9	4.30	1.8	0.50	16.80	10.7	98.21
5	Pilamedu	A_P	11.0	4.00	4.1	0.30	19.80	20.7	97.98
		B_1	9.8	5.28	3.81	0.82	19.91	19.1	99.00
		B_{SS1}	11.9	4.80	2.4	0.50	19.80	12.1	98.99

Soil site suitability evaluation for crops forms an essential part of every land use planning programme. Several soil and site characteristics are used as parameters for assessing the suitability of land for crops in every land evaluation exercise. The land is given a suitability rating depending on how well its properties meet the requirement of the crop. If all the properties match well with the crop requirements, the land is considered highly suitable otherwise less suitable (Moderate and marginal) and even not suitable, depending upon the deviation of the land properties from the optimal growth requirement of the crops.

Ground nut registered its suitability class of S_2 (Moderately suitable) in all the five soil series, except Eliyattur series, which had its unaltered limitation such as soil depth. The correctable minor limitations such as pH, organic carbon, alkalinity and drainage were observed in Ponnaniyar basin soils.

Table 4: Soil site suitability requirements for Ground nut

soil site characteristics			Rating			
		unit	Highly suitable S1	Moderately suitable S2	Marginally suitable S3	Not Suitable N1 N2
Climatic regime	Mean temp.	°C	30-24	22-23 31-33	20-21 34-40	>40 <20
	Total Rainfall	mm	700-1000	500-700	350-500	<350
Land Quality	Land characteristics					
Moisture avl.	LGP-Bunchy	Days	100-125	90-105	75-90	
	Spreading type	days	120-135	105-120	90-105	
Oxygen availability to roots	soil drainage	class	well drained	Mod. well	imperfectly drained	Poor drained
Nutrient availability	Texture class	surface	ls,sl	sicl, cl, scl	c,sic	
		subsurface	sil,l,scl,cl,sicl	Sc,c,sic	S,ls,sl,c>60	
	pH	1:2.5	6.0-8.0	8.1-8.5 5.5-5.9	>8.5 <5.5	
	CaCO3	%	high	medium	low	
Rooting conditions	Effective soil depth	cm	>75	75-51	50-25	<25
	EC	dS/m	<2	2-4	4-8	>8
	ESP	%	Non-sodic	5-10	>10	
Erosion Hazard	Slope	%	<3	3-5	5-10	>10

***Source*:** NBSS & LUP, Manual soil site suitability criteria, 2006.

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