



SOIL-SITE SUITABILITY EVALUATION FOR COTTON IN GIRNAR TOPOSEQUENCE OF SOUTHERN SAURASHTRA REGION OF GUJARAT

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ABSTRACT

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The five representative pedons were studied for soil-site suitability for cotton in the soils of different land slopes of Girnar toposequence of Southern Saurashtra region in Gujarat. The soils of hill slope (Lithic Ustorthents, P₁) and upper piedmont (Lithic Haplusteps, P₂) are marginally suitable (S₃) for cotton cultivation, lower piedmont (Typic Haplustert, P₃) are moderately suitable (S₂), whereas the soils of upper coastal plain (Typic Haplusteps, P₄) and coastal depression (Typic Ustifluvents, P₅) are currently not suitable (N₁) for cotton cultivation.

INTRODUCTION

The soils of Saurashtra region are unique in origin having diverse in genesis, physiography, climate, vegetation, depth, colour, age etc. An understanding of soil characteristics are helpful in the magnitude of changes that may have taken place during the development and in planning the proper management practices to its efficient use in land use planning. Therefore, it is worthwhile to characterize the soils of Girnar toposequence for better management Patel (2010). Yield of any crop is influenced by kind of soils occurring in the area, prevailing climate, topography and management levels. Thus, it is essential to interpret the soil-site characteristics of any place for the major crops grown in the area and alternative land use planning on sustainable basis. Cotton is a main fiber crop grown in southern Saurashtra region of Gujarat state. The cotton production in this area is not stable. Growing the crop without proper consideration of soil and site characteristics has result in lower yield and deterioration of soil health. For effective planning and better utilization of soil resources, information relating to soil-site suitability for cultivation of cotton is necessary.

MATERIALS AND METHODS

The study area (Girnar toposequence) is located between 21°30' to 21°38' N latitudes and 69°20' to 70°28' E longitudes. The area falls under semi-arid (dry) climate with mean annual rainfall is 706 mm. The representative water balance of the study area is given in Fig. 1. The temperature regime of the study area is hyperthermic in hill slope, upper piedmont and lower piedmont areas, whereas isohyperthermic in upper coastal plain and coastal depression (tidal) area (NBSS & LUP, 2000). Five representative pedons from different land slopes *viz.* P₁ (hill slope), P₂ (upper piedmont), P₃ (lower piedmont), P₄ (upper coastal plain) and P₅ (coastal depression) were selected during 2011-12 (Fig. 2). Physical and chemical characteristics were estimated by using standard procedure. The soil-site suitability for cotton was carried out using the Sys *et al.* (1991) with modification by NBSS & LUP (2000) with match soil site characteristics of different soil types of arrive at suitability class (Table 1). The soils were evaluated in different suitability classes *viz.* S₁- highly suitable, S₂- moderately suitable, S₃- marginally suitable, N₁- currently not suitable and N₂- not suitable (Sys *et al.*, 1993).

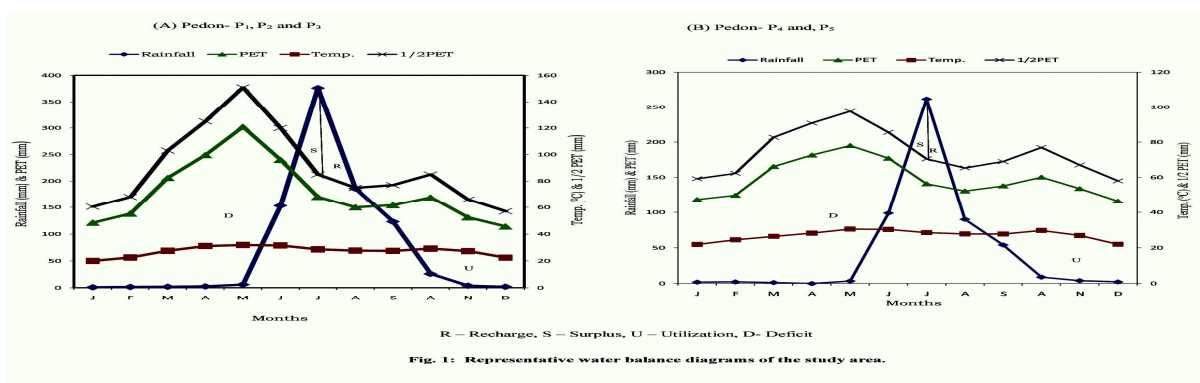


Fig. 1: Representative water balance diagrams of the study area.

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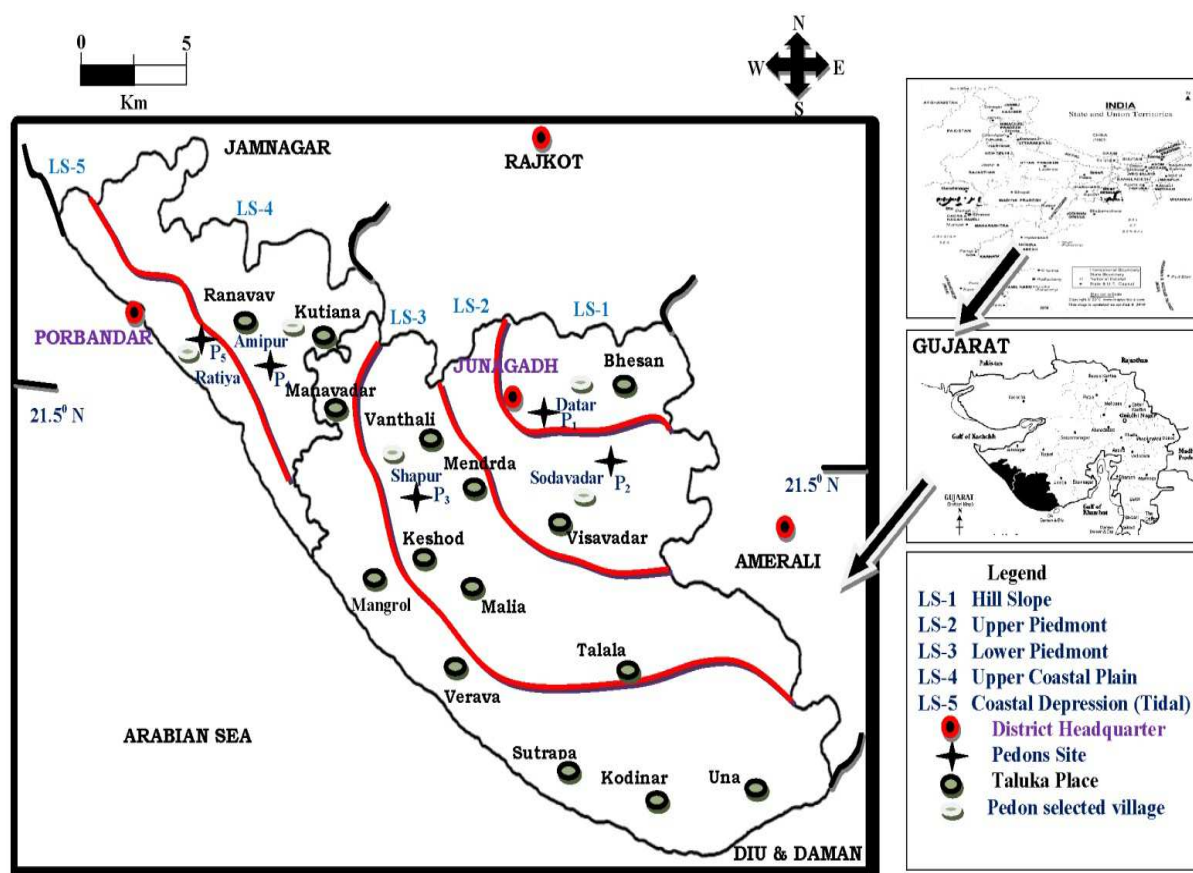


Fig. 2: Site of Pedons of the Girnar Toposequence in Southern Saurashtra

RESULTS AND DISCUSSION

Soil characteristics

The data pertaining to soil characteristics of different landforms of pedon P_1 to P_5 are presented in Table 2. The clay content ranged from 21.83 to 68.74 % (mean value of 39.40 %) indicates dominant of clay having loam to clayey texture. The pH ranged from 7.13 to 8.15 (mean value of 7.70) indicating slightly alkaline in reaction which might be due to well drained association with comparative high rainfall (Deshmukh and Bapat, 1993). The pH of soils were increasing sequence of Hill Slope < Upper Piedmont < Lower Piedmont < Upper Coastal Plain < Coastal Depression (Table 2). A thorough examination of the data revealed that an increase in soil pH gradually along the topography from hill slope to coastal depression (tidal) could be the result of continuous flow of bases from higher topography to lower topography. This finding is in conformity with that Savalia (2005).

The CaCO_3 content was found in the increasing order of Hill Slope < Lower Piedmont < Upper Coastal Plain < Coastal Depression (Tidal) < Upper Piedmont. The CaCO_3 increased along with down the slope and it registered its maximum value in Upper Piedmont (78.78 per cent) (Table 2) because the upper piedmont area,

especially Sodavadar village near Junagadh is a rich source of lime stone. The CEC ranged from 21.12 to 50.95 ($\text{cmol (P}^+)/\text{kg}$). The CEC was recorded in the increasing order of Hill Slope < Upper Piedmont < Lower Piedmont < Upper Coastal Plain < Coastal Depression (Tidal) indicating that CEC increased with decreasing topography. The content of BSP and ESP were found in increasing sequence of Hill Slope < Upper Piedmont < Lower Piedmont < Upper Coastal Plain < Coastal Depression (Tidal) indicating BSP and ESP increases with decreasing in elevation. The results are in concurrence with those obtained by Savalia (2005).

The comparatively lower value of ESP at higher elevation might be due to washing down the salts by rain. The higher value of ESP at lower elevated areas might be due to its mobility and position of profile in transect, poor drainage, shallow underground water and high Na salts. A fact corroborated by the finding of Patel (2010). In general, the soils of Girnar toposequence were slightly alkaline in reaction, highly calcareous in nature and low in organic carbon. The soil at higher elevation had low in pH, EC, CEC, BSP and ESP then lower elevation.

Table 1 Climate and soil-site suitability for cotton.

	1	2	3	4	5	6
Climatic characteristics						
Total rainfall (mm)		700-1050	550-700	< 550	-	-
Rainfall growing season (mm)		600-950	450-600	< 450	-	-
Rainfall during critical period		100-120	-	-	-	-
Length growing period (days)		> 135	120-135	< 120	-	-
Mean temp. ($^{\circ}$ C)		22.32	> 32	-	-	-
Maximum temp. ($^{\circ}$ C)		-	-	> 36	-	-
Minimum temp. ($^{\circ}$ C)		-	-	< 19	-	-
Relative Humidity (%)		60-90	-	< 50	-	-
Site characteristics						
Slope (%)		< 3	3-5	> 5	-	-
Erosion		e ₁	e ₂	e ₃	-	-
Drainage						
		Well to mod.	Imperfect	Poor & excessive	-	-
Water stagnation (days AWC (mm/m))		< 2	2-3	3-5	> 5	-
Stoniness (surface)		> 150	100-150	50-100	-	-
Soil characteristics texture		< 15	15-40	> 40	-	-
Texture		sic, siel, c, cl	scl, siel, l, sc	sl	s, ls	-
Coarse fragments (vol. %) within 50 cm		< 15	15-35	> 35	-	-
Below 50 cm		5-35	35-50	> 50	-	-
Depth (cm)		> 75	50-75	25-50	< 25	-
CaCO ₃ (%)		< 10	10-20	> 20	-	-
Gypsum (%)		-	-	-	-	-
Soil fertility						
CEC (cmol (p ⁺)/kg)		> 20	< 20	-	-	-
BS (%)		> 50	35-50	< 35	-	-
O.M. (%) (0-15 cm)		> 0.75	0.5-0.75	< 0.50	-	-
ECe (dS/m)		< 2	2-4	> 4	-	-
ESP		< 10	10-15	> 15	-	-
PH (1:2.5)		8.0-8.5	8.5-9.5	> 9.0	-	-

Soil-site suitability for cotton

The soil characteristics of studied pedons used in assessing suitability are presented in Table 3 while a perusal of data on degree of limitations and suitability of soils for cotton in Table 4 and 5.

Hill slope: The soils associated with pedon P₁ belong to Lithic Ustorthents are marginally suitable (S₃) for cotton cultivation because of major limitations like topography, texture and shallow soil depth. Soil conservation measures like graded narrow base terrace bunds or trench and contour bunding should be adopted (Patel, 2010).

Upper piedmont: The soils of pedon P₂ belong to Lithic Haplustepts are marginally suitable (S₃) for cotton because of major limitations like shallow soil depth and high CaCO₃.

Lower piedmont: The soils associated with pedon P₃ belong to Typic Haplustert have been evaluated to be moderately suitable (S₂) for cotton on account of only one major limitation likes high CaCO₃.

Upper coastal plain: The soils of pedon P₄ belong to Typic Haplustepts have been evaluated to be currently not suitable (N₁) for cotton. This may be due to the limitations like low rainfall, poor drainage, high CaCO₃, salinity and sodicity. On adoption of corrective measures of mulching, rain water leeching, adoption of salt tolerant crops and use of organic manures, the suitability class of cotton could be corrected.

Coastal depression (tidal): The soils of pedon P₅ belong to Typic Ustifluvents have been evaluated to be currently not suitable (N₁) for cotton. This may be due to major limitations like low rainfall, poor drainage, texture, high CaCO₃, salinity and sodicity. On adoption of corrective measures like provision of surface drainage through lateral ditches, adoption of salt tolerant varieties and use of organic manures along with gypsum could be corrected in these soils.

Table: 2 Soil characteristics of Girnar toposequence in southern Saurashtra (weighted mean).

Pedon	Particle size (%)			pH (1:2.5)	EC (dS/m)	Org. (%)	C	CaCO ₃ (%)	CEC (cmol (P ⁺) /kg	BSP (%)	ESP (%)
	Sand	Silt	Clay								
P ₁ : Lithic Ustorthents, MSL: 150m	41.68	36.48	21.83	7.13	0.29	1.01	2.30	21.12	90.57	0.54	
P ₂ : Lithic Haplustepts, MSL : 87 m	16.61	45.10	38.28	7.60	0.28	0.75	78.78	24.20	91.79	2.80	
P ₃ : Typic Haplustert, MSL : 70 m	12.63	16.65	68.74	7.73	1.05	0.71	14.28	29.35	92.84	4.94	
P ₄ : Typic Haplustepts, MSL : 15 m	25.72	38.02	36.43	7.92	3.20	0.50	21.15	48.84	95.46	15.87	
P ₅ : Typic Ustifluvents, MSL : 5 m	18.94	50.23	31.71	8.15	4.69	0.46	21.84	50.95	96.26	17.18	
Overall mean	23.12	37.30	39.40	7.70	1.91	0.50	27.67	34.89	93.38	8.27	

Table: 3 Soil characteristics of studied pedons using assessing suitability

Pedon	Climate (C)		Topography (slope %)	Wetness, (drainage) (w)	Physical characteristics (S)	Soil fertility characteristics (f)					Salinity / Alkalinity (n)		
	Rainfall (mm)	Temp. (°C)				Texture	Soil depth (cm)	AWC (mm/m)	CaCO ₃ (%)	O. carbon (%)	Base saturation (%)	CEC (cmol (P ⁺) kg	ECe (dS/m)
P ₁ : Hill slope, MSL: 150m	883	27.3	15-30	Well	l	25	148	2	1.01	90	21	0.21	0.54
P ₂ : Upper piedmont, MSL: 87m	883	27.3	1-3	Mod. well	sic	45	154	79	0.75	92	24	0.35	2.80
P ₃ : Lower piedmont, MSL: 70m	883	27.3	1-3	Mod. well	c	100	307	13	0.71	93	29	0.97	4.94
P ₄ : Upper coastal plain, MSL: 15m	529	26.9	0-1	Poor	c	150	211	21	0.50	95	49	3.11	15.87
P ₅ : Coastal depression, MSL: 5m	529	26.9	0-1	Poor	sicl	135	222	22	0.46	96	51	4.53	17.18

c – Clay, sic – Silty clay, sicl- Silty clay loam

CONCLUSION

Based on the present study it can be concluded that the soils of study area were slightly alkaline in reaction and highly calcareous in nature. The soils over lower piedmont belong to Typic Haplustert are moderately suitable (S₂) for cotton cultivation. The soils over hill

slope belong to Lithic Ustorthents and upper piedmont belong to Lithic Haplustepts are marginally suitable (S₃) for cotton cultivation. Whereas the soils over upper coastal plain belong to Typic Haplustepts and coastal depression (tidal) belong to Typic Ustifluvents are currently not suitable (N₁) for cotton cultivation.

Table 4. Soil-site suitability evaluation for the cotton in the soils of Girnar toposequence (Sys et al., 1991).

Land Slope	Pedon No.	Climate (C)		Wetness (w)		Physical characteristics (S)			Soil fertility (f)			Salinity / Hazards (n)	
		Rainfall	Temp.	Topography	Drainage	Texture	Depth	CaCO ₃	CEC	BSP	O.C.	ECe	ESP
1	2	3	4	5	6	7	8	9	10	11	12	13	14
LS ₁	P ₁	S ₁	S ₁	S ₃	S ₁	S ₂	S ₃	S ₁	S ₁	S ₁	S ₁	S ₁	S ₁
LS ₂	P ₂	S ₁	S ₁	S ₁	S ₁	S ₁	S ₃	S ₃	S ₁	S ₁	S ₁	S ₁	S ₁
LS ₃	P ₃	S ₁	S ₁	S ₁	S ₁	S ₁	S ₁	S ₂	S ₁	S ₁	S ₁	S ₁	S ₁
LS ₄	P ₄	S ₃	S ₁	S ₁	S ₃	S ₁	S ₁	S ₃	S ₁	S ₁	S ₁	S ₂	S ₃
LS ₅	P ₅	S ₃	S ₁	S ₁	S ₃	S ₂	S ₁	S ₃	S ₁	S ₁	S ₁	S ₃	S ₃

S₁ = Highly suitable, S₂ = Moderately suitable, S₃ = Marginally suitable and N₁ = Currently not suitable.

Table 5 Limitation levels of the land characteristics and land suitability class for cotton.

Pedon No.	Sub group	Soil-site suitability class for cotton
LS ₁ : P ₁ : Hill Slope, Datar, Tal. Junagadh, Dist. Junagadh, MSL : 150 m		
P ₁	Lithic Ustorthents	S ₃ ws
LS ₂ : P ₂ : Upper Piedmont, Sodavadar, Tal. Junagadh, Dist. Junagadh, MSL : 87 m		
P ₂	Lithic Haplustepts	S ₃ s
LS ₃ : P ₃ : Lower Piedmont, Shapur, Tal. Vanthli, Dist. Junagadh, MSL : 70 m		
P ₃	Typic Haplustert	S ₂ s
LS ₄ : P ₄ : Upper Coastal Plain, Amipur, Tal. Kutiana, Dist. Porbandar, MSL : 15 m		
P ₄	Typic Haplustepts	N ₁ cwsn
LS ₅ : P ₅ : Coastal Depression (Tidal), Ratiya, Tal. Porbandar, Dist. Porbandar, MSL : 5 m		
P ₅	Typic Ustifluvents	N ₁ cwsn

C= Climatic condition, w = Wetness, s = Physical characteristics, n = Salinity/Alkalinity hazard.

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