Agriculture for Sustainable Development 1(1):7-11, 2013/Article *ISSN 2347-5358 (Print)*

Agriculture for Sustainable Development

http://www.sustainableagriculture.in

SOIL-SITE SUITABILITY EVALUATION FOR SESAME IN CALCAREOUS SOILS OF GIRNAR TOPOSEQUENCE IN SOUTHERN SAURASHTRA REGION OF GUJARAT

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Received: 05.09.2013 **Revised accepted: 09.10.2013**

ABSTRACT

The five representative pedons were studied for soil-site suitability for sesame in the soils of different land slops of Girnar toposequence of Southern Saurashtra region in Gujarat. The soils of hill slope (Lithic Ustorthents, P_1) are not suitable for sesame cultivation, upper piedmont (Lithic Haplustepts, P_2) and lower piedmont (Typic Haplustert, P_3), are marginally suitable, whereas upper coastal plain (Typic Haplustepts, P_4) and coastal depression (Typic Ustifluvents, P_5) are currently not suitable for sesame cultivation.

Keywords:

Girnar toposequence, Limitations, Sesame, Soil-site suitability

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. Sesame (*Sesamum indicum*) is an oil seed crop grown in southern Saurashtra region of Gujarat state. The sesame 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 sesame is necessary.

MATERIALS AND METHODS

The study area (Girnar toposequence) is located between $21^0$30’ to $21^0$38’ N latitudes and $69^0$20’ to $70^0$28’ E longitudes. The area fails under semi-arid (dry) climate with mean annual rainfall is 706 mm. The temperature regime of the study area is hyperthermic in hill slope, upper piedmont and lower piedmont, whereas isohyperthermic in upper coastal plain and coastal depression (tidal) area (NBSS & LUP, 2000).

Five representative pedons from different land slops viz. P_1 (hill slope), P_2 (upper piedmont), P_3 (lower piedmont), P_4 (upper coastal plain) and P_5 (coastal depression) were selected during 2011-12 (Fig. 1). Physical and chemical characteristics were estimated by using standard procedure. The soil-site suitability for sesame was carried out using the FAO (1976) and Sys *et al.* (1991) 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.* S_1- highly suitable, S_2- moderately suitable, S_3- marginally suitable, N_1- currently not suitable and N_2- not suitable (Sys *et al.*, 1993).

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

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value of 39.40 per cent) indicates dominant of clay having loam to clayey texture.

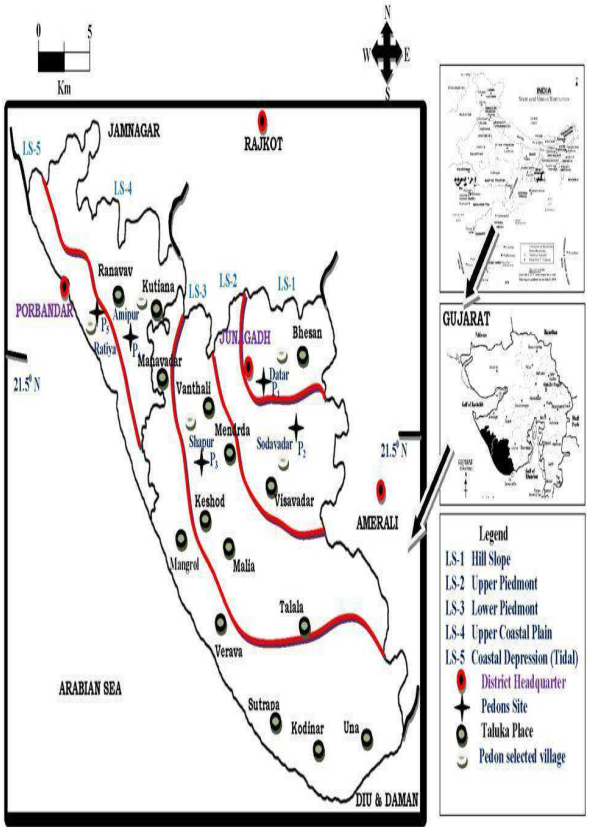

Figure 1. Site of pedons of the Girnar Toposequence in Southern Saurashtra

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 (Tidal) (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 were conform with Savalia (2005). The higher values of pH in upper coastal plain and coastal dipression (tidal) might be due high accumulation of soluble salts (Singh, 1999 and Savalia, 2005). The soils were low in organic carbon varied from 0.46 to 1.01 % (mean value of 0.50 %) which might be due to the prevalence of tropical condition, where the degradation of organic matter occurs at faster rate with low vegetation cover (Savalia, 2005 and Leelavathi et al., 2009). The $CaCO_3$ ranged from 2.30 to 78.78 % (with mean value of 27.67 %) indicating the soils were highly calcareous in nature.

Table 1: Climate and soil-site suitability criteria for sesame

Characteristics	S_1	S_2	S_3	N_1	N_2
Climatic (c)					
Precipitation (mm)					
Ist month	100-300	300-475	> 475	-	-
IInd month	175-100	100-50	50-25	-	< 25
IIIrd month	< 200	> 200	-	-	-
Mean maximum temperature (^{0}C)	35-38	38-40	40-42	-	> 42
Mean maximum temperature (^{0}C)	19-16	16-14	14-12	-	> 12
Topography (t)					
Slope (%)	0-2	2-4	4-6	-	> 6
Wetness (w)					
Drainage	Well to good	Imperfect	Poor and aenc	Poor but drainable	Poor not drainable
Physical characteristics (s)					
Texture / structure	1	Cs, co	C > 50 s	-	Cm , sicm
Coarse fragments (%)	0-15	15-35	35-55	-	> 55
Soil depth (cm)	> 75	75-50	50-35	-	< 30
Soil fertility characteristics (f)					
CEC cmol (p^+)/ kg	> 16	< 16 (+)	< 16(+)	-	-
B.S. (%)	> 50	50-55	< 35	-	-
pH, H_2O	6.3-7.0	7.0-7.5	7.5 8.2	-	> 8.2
Organic carbon (%)	> 1.2	1.2-0.3	< 0.8	-	-
Salinity/alkalinity (n)					
ECe (dS/m)	0-4	4-6	6-5	-	> 8

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 (cmol (P^+) kg^{-1}. 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). 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.

Soil-site suitability for sesame

perusal of data on degree of limitations and suitability of soils for sesame in Table 4 and 5.

Hill slope: The soils associated with pedon P_1 belong to Lithic Ustorthents are not suitable (N_2) for sesame cultivation because of major limitations like low rainfall, topography and shallow soil depth.

Upper piedmont: The soils of pedon P_2 belong to Lithic Haplustepts are marginally suitable (S_3) for sesame because of major limitations like low rainfall, topography, texture, shallow soil depth, and poor soil fertility (low O.C.). Similar result was also found by Patel (2010).

Lower piedmont: The soils associated with pedon P_3 belong to Typic Haplustert have been evaluated to be marginally suitable (S_3) for sesame on account of major limitations like low rainfall, topography, texture and poor soil fertility (low O.C.) (Savalia, 2005). The provision of surface drainage and use of organic manures with balanced fertilizers should be adopted for corrected these limitations.

The soil characteristics of studied pedons used in assessing suitability are presented in Table 3 while a

Upper coastal plain: The soils of pedon P_4 belong to Typic Haplustepts have been evaluated to be currently not suitable (N_1) for sesame. This may be due to the limitations like low rainfall, poor drainage, texture and poor soil fertility (low O.C.). On adoption of corrective measures of mulching, rain water leeching and use of organic manures, the suitability class of sesame could be corrected.

Coastal depression (tidal): The soils of pedon P_5 belong to Typic Ustifluvents have been evaluated to be currently not suitable (N_1) for sesame. This may be due to major limitations like low rainfall, poor drainage, texture, poor soil fertility (low O.C.), and salinity. On adoption of corrective measures like provision of surface drainage through lateral ditches (Savalia *et al*. 2009), 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. (^{0}C)			Texture	Soil depth (cm)	AWC (mm/m)	$CaCO_3$ (%)	Organic carbon (%)	Base saturation (%)	CEC (cmol (P^+) /kg	ECe (dS/m)	ESP
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: Coastal upper plain, MSL: 15m													
	529	26.9	0-1	Poor	c	150	211	21	0.50	95	49	3.11	15.88
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, l- Loam, sicl- Silty clay loam

Table: 4 Soil-site suitability evaluation for the sesame in the soils of Girnar toposequence (FAO, 1976 and Sys *et al.*, 1991).

Pedon No.	Climate (C)		Wetness (w)		Physical characteristics (S)		Soil fertility (f)			Salinity / Alkalinity (n)
	Rainfall	Temp. (^{0}C)	Topography	Drainage	Texture	Soil depth	CEC	BSP	OC	Salinity (ECe)
1	2	3	4	5	6	7	8	9	10	11
P_1	S_3	S_1	N_2	S_1	S_2	N_2	S_1	S_1	S_1	S_1
P_2	S_3	S_1	S_2	S_1	S_2	S_3	S_1	S_1	S_3	S_1
P_3	S_3	S_1	S_2	S_1	S_2	S_1	S_1	S_1	S_3	S_1
P_4	S_3	S_1	S_1	S_3	S_2	S_1	S_1	S_1	S_3	S_1
P_5	S_3	S_1	S_1	S_3	S_2	S_1	S_1	S_1	S_3	S_2

S_1 = Highly suitable, S_2 = Moderately suitable, S_3 = Marginally suitable, N_1 = Currently not suitable and N_2= Not suitable

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

Pedon No.	Sub group	Soil-site suitability class for groundnut.
LS_1 : P_1: Hill Slope, Datar, Tal. Junagadh, Dist. Junagadh, MSL : 150 m		
P_1	Lithic Ustorthents	N_2cws
LS_2 : P_2: Upper Piedmont, Sodavadar, Tal. Junagadh, Dist. Junagadh, MSL : 87 m		
P_2	Lithic Haplustepts	S_3cwsf
LS_3 : P_3: Lower Piedmont, Shapur, Tal. Vanthli, Dist. Junagadh, MSL : 70 m		
P_3	Typic Haplustert	S_3cwsf
LS_4 : P_4: Coastal Upper Plain, Amipur, Tal. Kutiana, Dist. Porbander, MSL : 15 m		
P_4	Typic Haplustepts	N_1cwsf
LS_5: P_5: Coastal Depression (Tidal), Ratiya, Tal. Porbandar, Dist. Porbandar, MSL : 5 m		
P_5	Typic Ustifluvents	N_1cwsfn

w = Wetness, s = Physical characteristics, f = Soil fertility characteristics, n = Salinity/Alkalinity hazard

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 upper piedmont belong to Lithic Haplustepts and lower piedmont belong to Typic Haplustert are marginally suitable (S3) for sesame cultivation. The soils over upper coastal plain belong to Typic Haplustepts and coastal depression (tidal) belong to Typic Ustifluvents are currently not suitable (N1) for sesame cultivation, whereas the soil over hill slop belong to Lithic Ustorthents are not suitable (N2) for sesame cultivation.

ACKNOWLEDGEMENT

The senior author is highly grateful to Dr. S. G. Savalia, Asso. Res. Scientist, J. A. U., Junagadh and Dr. J. D. Giri, Sr. Scientist, NBSS & LUP (ICAR) Nagpur (Maharashtra) for providing valuable suggestion and guideline during the course of study.

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