International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(2): 3364-3368

Received: 07-01-2018
Accepted: 08-02-2018

CM Savaliya
Department of Agricultural Chemistry and Soil Science, Junagadh Agricultural University, Junagadh, Gujarat, India

SG Savalia
Department of Agricultural Chemistry and Soil Science, Junagadh Agricultural University, Junagadh, Gujarat, India

DV Hirpara
Department of Agricultural Chemistry and Soil Science, Junagadh Agricultural University, Junagadh, Gujarat, India

VS Ranpariya
Department of Agricultural Chemistry and Soil Science, Junagadh Agricultural University, Junagadh, Gujarat, India

VL Modhavadiya
Department of Agricultural Chemistry and Soil Science, Junagadh Agricultural University, Junagadh, Gujarat, India

Correspondence
CM Savaliya
Department of Agricultural Chemistry and Soil Science, Junagadh Agricultural University, Junagadh, Gujarat, India

Soil-site suitability evaluation for coconut and oil palm in the soils of Ozat River valley of southern Saurashtra region of Gujarat

CM Savaliya, SG Savalia, DV Hirpara, VS Ranpariya and VL Modhavadiya

Abstract
Eight representative pedons were evaluated for their soil site suitability for coconut and oil palm in the soils of different pedons of ozat river valley of southern saurashtra region of gujarat. The soils of lower piedmont belong to Lithic Ustorthents (P_1) and Lithic Ustorthents (P_7) were currently not suitable (N_1) for coconut and oil palm. The soils of upper plain area belongs to Vertic Haplusterts (P_2), Lithic Ustorthents (P_4), Typic Haplusterts (P_6), Typic Haplustepts (P_8) and soils of lower piedmont belongs to Vertic Haplustepts (P_3), Vertic Haplustepts (P_5) were marginally suitables (S_3) for coconut and oil palm. Topography, drainage, shallow soil depth, low rainfall, texture, poor soil fertility (soil pH) soil salinity and alkalinity are the major limitations for cultivation of coconut and oil palm in soils of ozat River Valley of Southern Saurashtra Region of Gujarat.

Keywords: soil-site suitability, pedon, coconut, oil palm

Introduction
The coconut Kalpvriksh (Tree of heaven) is a most beautiful and useful versatile tropical plant plays a major role in the economy of India. The coconut palm exerts a profound influence on the rural economy of the many states where it is grown extensively and it provides sustenance to more than 10 million people. Coconut is widely used coconut oil, milk, cream, coconut water, desiccated coconut, coconut flour, oil cake, soaps, hair oil, cosmetics, coir and coconut fiber. Oil palm is a tropical tree crop which is demand continues to grow because it is the most versatile of all vegetable oils. Increasing population requirement increases of edible oil demand. Soil is vital natural resource on whose proper use depend the life supporting system of a country and the socio-economic development of its people. With the increase of demand for land, land evaluation has become more important as people strive to make better use of the limited land resources. Land evaluation is the process of assessment land performance for specified purposes. Yield of any crop is influenced by kind of soils occurring in the area, prevailing climate, topography and management levels. The crop management practices based soil and site suitability criteria may help to overcome the constraints of crop planning for maximizing the production. It also helps in appraisal of suitability of a particular crop in specific soil area. Land suitability evaluation is the process of estimating the potential of land for land use planning (F.A.O., 1976, Sys *et al.*, 1991, Savalia, 2005, Patel, 2010 and Gandhi *et al.*, 2013) [13, 11, 10, 3].

Material and Method
The study area (Ozat river valley) was located between $21^0$13’ to $22^0$13’ N latitudes and $69^0$19’ to $70^0$38’ E longitudes encompassing parts of the Mendarda, Visavadar and Junagadh tehsils of Junagadh district of Southern Saurashtra an elevation ranges from 44.7 to 98.2 m above mean sea level. IRS IA LISS II FCC imagery on 1:50,000 Scale on conjunction with

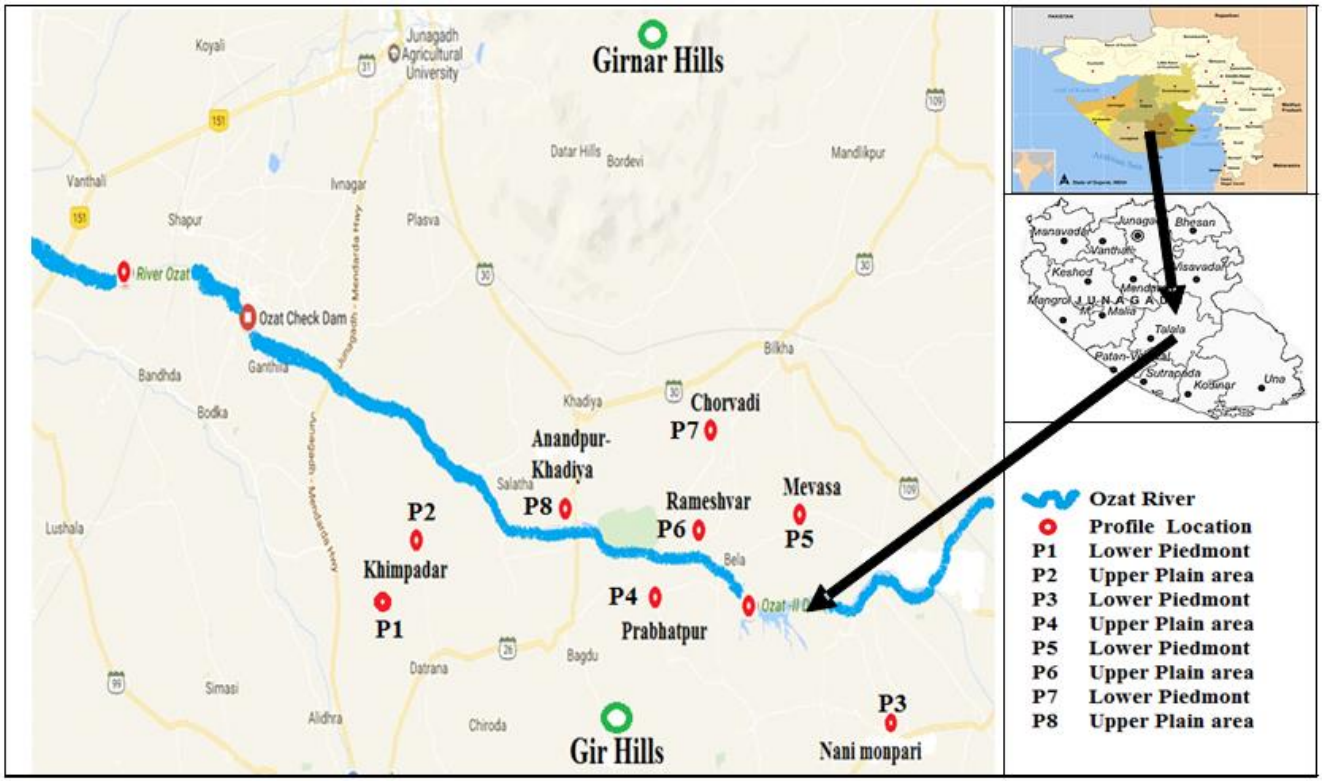

Fig 1: Site of pedons of ozat River Vally in southern Saurashtra region of Gujarat

topographical (SOI) map referred above on 1:50,000 Scale were used to select various ground slopes of Ozat River Valley of Southern Saurashtra region of Gujarat namely: lower piedmont (LS-1), upper plain area (LS-2), lower piedmont (LS-3), upper plain area (LS-4), lower piedmont (LS-5), upper plain area (LS-6), lower piedmont (LS-7), upper plain area (LS-8) in calcareous basaltic soils of Ozat River Valley of Southern Saurashtra. The mean annual rainfall is 1125 mm and the climate of the area is semi-arid characterized by extremes of temperature and low wind velocity. Horizon-wise soil samples collected from the typifying pedons were analysed for their physical and chemical characteristics following standard procedure and soils were classified according to Key to Soil Taxonomy (Anonymous, 2003).The soil-site suitability for coconut and oil palm were carried out using limitation method and matched with generated data (Table: 1 and 2) at different limitation level: S_1- highly suitable, S_2- moderately suitable, S_3- marginally suitable, N_1- currently not suitable and N_2- not suitable. The soil-site suitability for coconut was carried out by Naidu *et al.*, (1997) [7] and for oil palm was carried out by NBSS & LUP (1994) [8].

Results and Discussion

In general, the soils of of Ozat River Valley of Southern Saurashtra were moderately alkaline in reaction, low in organic carbon status and highly calcareous in nature.

Pedon-1 (Khimpadar) from Lower piedmont: The soils associated with this pedon were currently not suitable (N_1) for coconut and oil palm cultivation. Major limitations for coconut like rainfall, drainage, texture, shallow soil depth and pH and for oil palm like rainfall, high temp., drainage, texture, soil depth, pH, Ec_e and ESP. Soil conservation measures like graded narrow base terrace bunds or trenches and contour banding and application of organic mannurs, compost *etc.*, and chemical fertilizers as per soil test report should be adopted (Savalia *et al*., 2009) [12].

Table 1: Climate and soil-site suitability criteria for coconut (Naidu *et al.*, 1997) [7]

Land-use requirement	Soil-site characteristics	Highly suitable S_1	Moderately suitable S_2	Marginally suitable S_3	Currently not suitable N_1
Climatic regime	Mean temp, in growing season (°C)	26-29	23-25 30-32	33-34 20-22	
	Total rainfall (mm)	1500-2500	1000-1500	500-1000	<500
	Dry months (months with <50 mm rainfall)	<3	4-5	6-7	-
Land quality	Land characteristics				
Oxygen availability to roots	Depth of water table (M)	2-3	1-2	0.5-1	-
	Soil drainage	WD	MW	IM to ED	PD
Nutrient availability	Texture	scl, sil, cl, sc, sicl	sl, sic, c (non-swelling)	c (swelling), ls, s	-
	pH (1:2.5)	5.1-6.5	6.6-7.5; 4.5-5.0	7.6-8.5; 4.0-4.4	-
Rooting conditions	Effective soil depth (cm)	>100	75-100	50-75	<50
	Coarse fragments (vol %)	<15	>15-35	35-50	>50
Erosion	Slope	<8	8-15	15-30	-

Pedon-2 (Khimpadar) from the Upper plain area: The soils associated with this pedon marginally suitable (S_3) for coconut and oil palm cultivation. Major limitation for coconut likerainfall, drainage, texture, soil depth and soil pH and for oil palm like rainfall, temp., drainage, texture, soil depth, pH, Ec_e and ESP. Use of organic manures along with inorganic fertilizers should be adopted. Graded narrow base terrace bunds or trenches are recommended to increase soil depth/rooting volume, conservation tillage and forage-based crop rotations which reduce erosion and allow soil forming factors to maintain and rehabilitate top soil. Similar observations were also made by (Golakiya and Gundalia, 2000) [5].

Table 2: Climate and soil-site suitability criteria for oil palm (NBSS & LUP, 1994)

Land-use requirement	Soil-site characteristics	Highly suitable S_1	Moderately suitable S_2	Marginally suitable S_3	Currently not suitable N_1
Climatic regime	Mean temp, in growing season (°C)	28-33	27-26 34-35	>35	
	Total rainfall (mm)	2000-2800	1500-2000	1000-1500	<1000
	Mean relative humidity (%)	>75	75-60	50-60	<50
	Months with rainfall <100 (mm)	<3	3-4	>4	-
Land quality	Land characteristics				
Oxygen availability to roots	Soil drainage	WD	MW to IM	ED to P	PD
	Depth of water table (cm)	>250	100-250	<100	-
Nutrient availability	Texture	cl, scl, l, sil	sl, sicl, c, sic	ls, s, c (swelling)	-
	pH (1:2.5)	5.0-6.5	6.6-8.0; 4.0-4.9	>8.0; <4.0	>6.5
Rooting conditions	Effective soil depth (cm)	>100	75-100	50-75	<50
	Stoniness (%)	Nil	>15-35	>35	>35
Soil toxicity	Salinity (ECe) (dS m^{-1})	1-2	2-4	4-8	>8
	Sodicity (ESP)	Non-sodic	<10	10-15	-
Erosion	Slope	5-10	10-17	18-25	>25

Pedon-3 (Nanimonpari) from the Lower piedmont: The soils associated with this pedon marginally suitable (S_3) for coconut and oil palm cultivation. Major limitation for coconut like rainfall, drainage, texture, shallow soil depth and pH and for oil palm rainfall, Temp., drainage, texture, soil depth, pH, Ece and ESP On adoption of corrective measures for increase soil organic matter, zero or minimum tillage, legume based and other crop rotation, cover crops and forage crops should be practiced. Use of organic manures along with balanced fertilizers should be adopted. Provision of drainage whenever required. Frequent interculturing immediately after the soil attains field capacity, will help in improving soil aeration. Use of recycling and organic waste should be adopted. Similar observations were also made by Patel (2010) [10] and Niranjana *et al.*, (2011) [9].

Table 3: Soil-site suitability evaluation and land qualities for the coconut and oil palm of the soils of ozat River Vally in southern Saurashtra

Pedon No.	Climate (c)		Wetness (w)		Physical & chemical characteristics (s)			Soil fertility characteristics (f)				Salinity/ alkalinity (n)	
	Rainfall (mm)	Temp. (^{0}C)	Topography (slope %)	Drainage	Texture	Soil depth (cm)	$CaCO_3$ (%)	O.C. (%)	BSP	CEC (cmol(p^+)kg^{-1})	pH	ECe (dSm^{-1})	ESP
1	2	3	4	5	6	7	8	9	10	11	12	13	14
P_1	1125	27.31	0-1	Moderately Well	c	45	19.25	0.74	93.42	35.15	7.31	3.13	8.11
P_2	1125	27.31	0-1	Moderately Well	c	110	58.25	0.72	91.99	39.35	7.62	2.31	7.86
P_3	1125	27.29	0-1	Moderately Well	c	75	46.75	0.35	95.82	36.93	7.34	2.54	6.90
P_4	1125	27.31	0-1	Moderately Well	sic	50	15.00	0.44	94.00	40.03	7.52	1.65	4.81
P_5	1125	27.23	0-1	Moderately Well	c	63	47.33	0.50	93.35	37.28	7.62	1.33	4.00
P_6	1125	27.23	0-1	Moderately Well	c	75	33.00	0.86	93.78	38.72	7.36	2.09	5.82
P_7	1125	27.23	0-1	Moderately Well	c	25	17.50	0.54	94.13	38.97	7.36	2.89	6.73
P_8	1125	27.23	1-3	Imperfect	c	60	60.33	0.47	91.27	38.91	7.40	1.87	3.77

c- clay, cl- clay loam, sil: silty loam, sic: silty clay

Pedon-4 (Rameshvar) from Upper plain area: The soils associated with this pedon marginally suitable (S_3) for coconut and oil palm cultivation. Major limitation for coconut like rainfall, drainage, texture, soil depth and soil pH and for oil palm like rainfall, temp., drainage, soil depth, texture, pH, Ece and ESP. On adoption of corrective measures of agronomic practices such as soil profile modification (chiseling deep ploughing), changing the land configuration by special planting practices and / or irrigation management, mulching and rain water leaching and adoption of salt tolerant cultivars could be help in boosting the crop production in plain area. Similar observations were also made by Patel, (2010) [10] and Niranjana *et al.*, (2011) [9]

Pedon-5 (Mevasa) from Lower piedmont: The soils associated with this pedon marginally suitable (S_3) for coconut and oil palm cultivation. Major limitation for coconut like rainfall, soil depth, drainage,texture and soil pH and for oil palm like rainfall, temp., drainage, soil depth, texture, pH, Ece, and ESP. On adoption of corrective measures of mulching, broad beds and furrow system, rain water leaching, use of organic manures and use of gypsum *etc*the suitability class could be corrected. Similar observations were also made by Patel, (2010) [10] and Niranjana*et al.*, (2011) [9].

Pedon-6 (Rameshvar) from Upper plain area: The soils associated with this pedon marginally suitable (S_3) for

coconut and oil palm cultivation. Major limitation for coconut like rainfall, drainage, soil depth, texture, and high pH and for oil palm like rainfall, temp., drainage, soil depth, texture, pH, Ece and ESP. On adoption of corrective measures like provision of surface drainage through lateral ditch (Giri *et al.*, 1999) [4], use of organic manures along with gypsum and nitrogenous fertilizers and soil and water conservation practices could be adopted in these soils to make them productive. Similar observations were done by Savalia (2005) [11] and Patel (2010) [10].

Table 4: Soil-site suitability evaluations for coconut in the soils of Ozat River Vally in southern Saurashtra

Pedon No.	Climate (c)		Wetness (w)		Physical characteristics (s)		Soil fertility characteristics (f)		Crop suitability class
	Rainfall (mm)	Temp. (^{0}C)	Topography (slope %)	drainage	Texture	Soil depth (cm)	BSP	pH	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
P_1	S_2	S_1	S_1	S_2	S_2	N_1	S_1	S_2	N_1cwsf
P_2	S_2	S_1	S_1	S_2	S_2	S_1	S_1	S_3	S_3 cwsf
P_3	S_2	S_1	S_1	S_2	S_2	S_3	S_1	S_2	S_3cwsf
P_4	S_2	S_1	S_1	S_2	S_2	S_3	S_1	S_2	S_3 cwsf
P_5	S_2	S_1	S_1	S_2	S_2	S_3	S_1	S_3	S_3 cwsf
P_6	S_2	S_1	S_1	S_2	S_2	S_3	S_1	S_2	S_3cwsf
P_7	S_2	S_1	S_1	S_2	S_2	N_1	S_1	S_2	N_1cwsf
P_8	S_2	S_1	S_1	S_3	S_2	S_3	S_1	S_2	S_3 cwsf

Table 5: Soil-site suitability evaluations for oil palm in the soils of Ozat River Vally in southern Saurashtra

Pedon No.	Climate (c)		Wetness (w)		Physical characteristics (s)		Soil fertility characteristics (f)	Salinity/ alkalinity (n)		Crop suitability class
	Rainfall (mm)	Temp. (^{0}C)	Topography (slope %)	Drainage	Texture	Soil depth (cm)	pH	ECe (dSm^{-1})	ESP	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
P_1	S_3	S_2	S_1	S_2	S_2	N_1	S_2	S_2	S_2	N_1cwsfn
P_2	S_3	S_2	S_1	S_2	S_2	S_1	S_2	S_2	S_2	S_3 cwsfn
P_3	S_3	S_2	S_1	S_2	S_2	S_3	S_2	S_2	S_2	S_3 cwsfn
P_4	S_3	S_2	S_1	S_2	S_2	S_3	S_2	S_1	S_2	S_3 cwsfn
P_5	S_3	S_2	S_1	S_2	S_2	S_3	S_2	S_1	S_2	S_3 cwsfn
P_6	S_3	S_2	S_1	S_2	S_2	S_3	S_2	S_2	S_2	S_3 cwsfn
P_7	S_3	S_2	S_1	S_2	S_2	N_1	S_2	S_2	S_2	N_1cwsfn
P_8	S_3	S_2	S_1	S_2	S_2	S_3	S_2	S_1	S_2	S_3 cwsfn

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

Pedon-7 (Chorvadi) from Lower piedmont: The soils associated with this pedon were currently not suitable (N_1) for coconut and oil palm cultivation. Major limitation for coconut like rainfall, moderately well drainage, texture, shallow soil depth and soil pH and also for oil palm rainfall, moderately well drainage, temp., texture, shallow soil depth, soil pH, Ece and ESP. Soil conservation measures like graded narrow base terrace bunds or trenches and contour bunding and application of FYM and chemical fertilizer as per soil test should be adopted (Savalia *et al*., 2009) [12].

Table 6: Limitation levels of the land characteristics and land suitability class for coconut and oil palm

No. of Pedon	Sub group	Soil-site suitability class for	
		Coconut	Oil palm
Pedon-1 (P_1)	Lower piedmont (Khimpadar), MSL: 65 m, 21^{0}13' N latitudes, 70^{0}27' E longitude, Lithic Ustorthents	N1cwsf	N_1cwsfn
Pedon-2 (P_2)	Upper plain area (Khimpadar), MSL: 65 m, 21^{0}13' N latitudes, 70^{0}27' E longitude, VerticHaplusterts	S_3 cwsf	S_3 cwsfn
Pedon-3 (P_3)	Lower piedmont (Nanimonpari), MSL: 98.2 m, 21^{0}21' N latitudes, 70^{0}38' E longitude, VerticHaplustepts	S_3cwsf	S_3 cwsfn
Pedon-4 (P_4)	Upper plain area (Prabhatpur), MSL: 72.9 m, 21^{0}23' N latitudes, 70^{0}32' E longitude, Lithic Ustorthents	S_3 cwsf	S_3 cwsfn
Pedon-5 (P_5)	Lower piedmont (Mevasa), MSL: 44.7 m, 22^{0}13' N latitudes, 69^{0}19' E longitude, VerticHaplustepts	S_3 cwsf	S_3 cwsfn
Pedon-6 (P_6)	Upper plain area (Rameshvar), MSL: 71 m, 21^{0}23' N latitudes, 70^{0}33' E longitude, TypicHaplusterts	S_3cwsf	S_3 cwsfn
Pedon-7 (P_7)	Lower piedmont (Chorvadi), MSL: 76.9 m, 21^{0}24' N latitudes, 70^{0}34' E longitude, Lithic Ustorthents	N_1cwsf	N_1cwsfn
Pedon-8 (P_8)	Upper plain area (Anandpur-khadiya), MSL: 58.5 m, 21^{0}24' N latitudes, 70^{0}31' E longitude, TypicHaplustepts	S_3 cwsf	S_3 cwsfn

S1 = Highly suitable, S2 = Moderately suitable, S3 = Marginally suitable, N1 = Currently not suitable, w = Wetness, s =Physical characteristics, f = Soil fertility characteristics, n = Salinity/Alkalinity hazard

Pedon-8 (Anandpur-khadiya) from Upper plain area: The soils associated with this pedon marginally suitable (S_3) for coconut and oil palm cultivation. Major limitation for coconut like rainfall, drainage, texture, soil depth and soil pH and for oil palm like rainfall, temp., drainage, texture, pH, soil depth, Ece and ESP. For increase soil organic matter, zero or minimum tillage, legume based and other crop rotation, cover crops and forage crops should be practiced. Use of organic manures along with balanced fertilizers should be adopted. Provision of drainage whenever required. Frequent interculturing immediately after the soil attains field capacity, will help in improving soil aeration.

Conclusion

Based on the present study it can be concluded that the soils of study area were moderately alkaline in reaction and highly calcareous in nature. The soils of lower piedmont belong to Lithic Ustorthents (P_1) and Lithic Ustorthents (P_7) were currently not suitable (N_1) for coconut and oil palm. The soils of upper plain area belongs to Vertic Haplusterts (P_2), Lithic

Ustorthents (P_4), Typic Haplusterts (P_6), Typic Haplustepts (P_8) and soils of lower piedmont belongs to Vertic Haplustepts (P_3), Vertic Haplustepts (P_5) were marginally suitables (S_3) for coconut and oilpalm.

References

1. Anonymous. Keys to Soil Taxonomy. USDA Natural Resources Conservation Service, Washington DC, 2003.
2. FAO. A frame work for land evaluation. Soils Bulletin, 32: FAO, Rome, 1976.
3. Gandhi G, Savalia SG, Verma HP. Soil-site suitability evaluation for sesame in calcareous soils of Girnar toposequence in Southern Saurashtra region of Gujarat. Journal of Agriculture for Sustainable Development. 2013; 1(1):7-11.
4. Giri JD, Singh RS, Shyampura RL, Jain BL. Soil and evaluation along coastal Gujarat for alternate land use options. J Indian Soc. Coastal Agric. Res. 1999; 17(1-2):76-79.
5. Golakiya BA, Gundalia JD. Crop production constraints and their remedies in calcareous soils of Gujarat. Procedding of the GAU-PRII-PI National Symp. On "Balanced nutrition of groundnut and other field crops grown in calcareous soils of India", Extended summaries of posters. 2000; II:193-204.
6. Gundalia JD, Savalia SG, Qureshi AU. Genesis, development and classification of calcareous soils of Saurashtra region. Calcareous Soils of Saurashtra and Their Management. Deptt. Agril. Chem. & Soil Sci., GAU, Junagadh. SSGA No. 2000; 12:9-17.
7. Naidu LGK, Krishnan P, Nair KM, Venugopal KR. Evaluation of land suitability of major coconut growing areas of India. Indian J Agric. Sci. 1997; 67(2):58-62.
8. NBSS, LUP. Proc. National meets on soil-site suitability criteria for different crops. Feb. 7-8, 1994 held at NBSS and LUP (ICAR), New Delhi, 1994.
9. Niranjana KV, Ramamurthy V, Hegde R, Srinivas S, Koyal A, Naidu LGK, *et al*. Characterization and classification and suitability evaluation of banana growing soils of Pulivendla region, Andhra Pradesh. J of Indian Soc. Soil Sci. 2011; 59(1):1-5.
10. Patel HP. Characterization, classification and evaluation of soil and water resources of the soils of different land of Meghal Irrigation Command area of Southern Saurashtra. M.Sc. Thesis, JAU, Junagadh, 2010.
11. Savalia SG. Characterization, classification and evaluation of soil and water resources across the toposequences of Southern Saurashtra. Ph.D. Thesis submitted to JAU, Junagadh, 2005.
12. Savalia SG, Kachhadiya SP, Solanki MS, Gundalia JD. Assessment and management of Soil Sustainability of calcareous soils in different landforms in a transect over basaltic trap. An Asian J. Soil Science. 2009b; 4(1):86-92.
13. Sys IC, Vanrasant B, Debavye J. Land evaluation, Part II and III. Methods in land evaluation. Agric. Pub. General administration for development co-operation place, de, camp de mars, Brussels, Belgium. 1991; 5:57-1050.