



Soil-site suitability for Indian mustard in Jamnagar district of Gujarat

ST Shirgire^{1*}, SG Savalia and PR Nanaware²

Department of Soil Science and Agricultural Chemistry, College of Agriculture,
JAU, Junagadh (Gujarat)-362 001 India

¹Department of Soil Science and Agricultural Chemistry, N.M. College of Agriculture NAU,
Navsari (Gujarat)-396 450 India

²Department of Vegetable Science, ACHF, NAU, Navsari-396 450

*Corresponding author: sunilshirgire22@gmail.com

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Abstract

Nine typical pedons of soils of Jamnagar district in Saurashtra region, Gujarat were evaluated for their suitability to Indian mustard [*Brassica juncea* (L.) Czern & Coss.] cultivation limitations i.e. number and intensity of limitations. The study suggests that Indian mustard is moderately suitable in soils of Pedon P₄, P₅ and P₉, but marginally suitable in soils of Pedon P₁, P₂, P₆ and P₇. However, the soils of Pedon P₃ and P₈ seems to be not suitable for Indian mustard cultivation. Soil depth, drainage, topography, and sodicity are the major limitations for crop growth in most of the soils of Jamnagar district. Results showed that the soil suitability classes can be improved if the correctable limitations (soil depth and drainage characteristics) are altered through soil amelioration measures.

Key words: *Brassica juncea*, limitations, potential, soil-site suitability

Introduction

Soil is recognized as one of the most valuable natural resources on whose proper use depend the life supporting systems, and socio-economic development. Indiscriminate use of land resources, in general, leads to their degradation and in-turn decline in the productivity. They need to be used according to their capacity to satisfy the needs of its inhabitants. This can be achieved through proper investigations of land resources, and their scientific evaluation. Land suitability evaluation is the process of estimating the potential of land for land use planning (Sys *et al.*, 1991). Several workers have worked out the suitability of soils for various crops such as cotton (Sehgal, 1991; Mandal *et al.*, 2002), wheat (Sharma, 1999), sorghum (Pakhan *et al.*, 2010), rubber (Kharche *et al.*, 1995) and mustard (Gandhi and Savalia, 2014). However, such information on soils of Jamnagar district of Gujarat in India is very scanty hence, the present study was undertaken to evaluate soil-site suitability for mustard crop in Gujarat.

Materials and Methods

The study area lies between 21° 47' and 22° 57' North latitude and 68° 57' and 70° 37' West longitude encompassing Jamnagar district northern part in Saurashtra region of Gujarat, India. The average annual rainfall is 670 mm and the climate of the area is arid and semi- arid characterized by extremes of temperature and low wind velocity. The mean annual temperature varies from 24°C to 43°C and temperature regime of the area is *hyperthermic*. The water balance of the study area is given in Fig. 1. Twenty representative (0-20 cm) soil samples were collected from each talukas of Jamnagar district viz. Jamjodhpur, Bhanvad, Kalyanpur, Dwarka, Kalavad, Jamnagar, Lalpur, Jamkhambhalia and Jodiya. Nine typical pedons representing major land forms of pediment slope (P₄, P₅, P₆, P₇, P₈), pediment plain (P₁, P₂, P₃) and alluvial plain (P₉) were studied for their physical, physico-chemical and chemical properties of following standard procedures. These pedons were evaluated for their suitability using limitation method regarding number and intensity of limitations

Table 1. Climate and soil-site suitability criteria for Indian mustard

Land Characteristics	Rating Class				
	S ₁	S ₂	S ₃	N ₁	N ₂
Climatic (c)					
Precipitation (mm)	250-350	150-250	100-150	< 100	-
Mean temp.(°C)	20-28	18-20	16-18	< 16	-
Topography (t)					
Slope (%)	< 3	3-8	3-8	> 8	-
Wetness					
Drainage	Moderately well drained	Imp./ somewhat excessive	Very low	-	-
Physical characteristics (s)					
Texture / structure	cl, l	sl	ls	s	-
Coarse fragments (%)	< 15	15-35	> 35	-	-
Soil depth (cm)	> 75	75-50	50-25	< 25	-
CaCO ₃ (%)	< 20	20-30	30-40	> 40	-
Gypsum (%)	< 3	3-5	5-10	> 10	-
Soil fertility characteristics (f)					
CEC cmol (P ⁺) kg ⁻¹	> 16	8-16	< 8	-	-
B.S. (%)	> 50	50-35	< 35	-	-
Organic carbon (%)	> 0.4	0.2-0.4	0.1-0.2	-	-
Salinity alkalinity (n)					
ECe (dsm ⁻¹)	< 8	8-12	12-16	> 16	-
ESP (%)	< 15	15-25	25-35	> 35	-

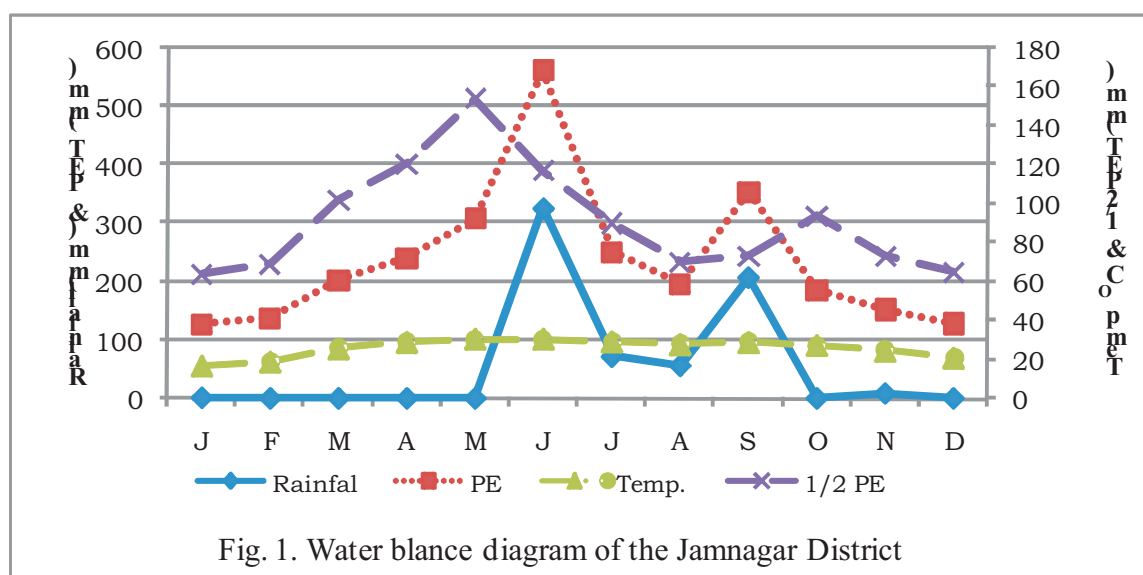


Fig. 1. Water balance diagram of the Jamnagar District

Table 2. Soil characteristics of Jamnagar District in Northern Saurashtra (weighted mean)

Pedons	Place and landform	Sub-group	pH (1:2.5)	ECe' (dSm ⁻¹)	Org C (%)	CaCO ₃ (%)	ESP	CEC [cmol (P+) kg ⁻¹]
P ₁	Chiroda, Tal: Jamjodhpur Pediment plain	Lithic Troparthents	7.97	3.43	0.53	5.2	14.6	34.0
P ₂	Mevasa Tal: Bhanvad Pediment plain	Lithic Ustorhents	8.26	4.04	0.51	4.4	10.9	37.3
P ₃	Mahadevia Tal: Kalyanpur Pediment plain	Lithic Ustorhents	8.27	4.86	0.52	5.8	13.0	43.7
P ₄	Varvala Tal: Dwarka Piedmont slope	Typic Ustochrepts	8.22	5.07	0.42	5.0	17.1	33.0
P ₅	Jamvali Tal: Kalavad Piedmont slope	Vertic Troparthents	8.14	3.15	0.55	6.9	11.2	31.0
P ₆	Changa Tal: Jamnagar Piedmont slope	Lithic Ustochrepts	8.16	4.14	0.53	5.1	14.3	36.7
P ₇	Pipali Tal: Lalpur Piedmont slope	Lithic Ustochrepts	8.12	3.54	0.48	5.7	13.6	36.5
P ₈	Nyara Tal: Jamkhambhalia Piedmont slope	Lithic Ustorhents	8.16	4.25	0.52	5.4	12.4	36.6
P ₉	Rasnal Tal: Jodiya Alluvial plain	Typic Ustochrepts	8.23	4.04	0.47	4.4	14.1	40.3

Table 3. Soil characteristics of studied pedons using assessing suitability

Pedons	Climate (C)		Wetness (w)		Physical characteristics (S)			Soil fertility characteristics (f)			Salinity / Alkalinity (n)		
	Rainfall (mm)	Temp. (°C)	Topo-graphy (slope) (%)	Drainage	Texture	Soil depth (cm)	AWC (mm/m)	CaCO ₃ (%)	Organic carbon (%)	pH	CEC [cmol (P ⁻) kg ⁻¹]	ECe' (dSm ⁻¹)	ESP
P ₁	670	25.8	1-3	Moderate	scl	46	200	5.24	0.53	7.97	34.0	3.43	14.6
P ₂	670	25.8	1-3	Well	cl	38	188	4.41	0.51	8.26	37.3	4.04	10.9
P ₃	701	25.8	3-5	Well	c	21	221	5.84	0.52	8.27	43.7	4.86	13.0
P ₄	378	25.8	3-5	Mod. Well	scl	63	210	5.06	0.42	8.22	33.0	5.07	17.1
P ₅	670	25.8	1-3	Imperfect	cl	55	239	6.99	0.55	8.14	31.0	3.15	11.2
P ₆	670	25.8	3-8	Well	sl	45	220	5.14	0.53	8.46	36.7	4.14	14.3
P ₇	628	25.8	3-5	Imperfect	cl	30	203	5.79	0.48	8.12	36.5	3.54	13.6
P ₈	614	25.8	3-8	Well	scl	23	195	5.49	0.52	8.16	36.6	4.25	12.4
P ₉	455	25.8	1-3	Well	cl	80	201	4.41	0.47	8.23	40.3	4.04	14.1

Table 4. Soil-site suitability evaluation and land suitability class for the Indian mustard in the soils of Jannagar District in Northern Saurashtra region

Pedons	Climate (C)		Wetness (w)		Physical characteristics (S)			Soil fertility characteristics (f)			Salinity / Alkalinity (n)		Crop suitability class
	Rainfall	Temp. (°C)	Topo-graphy	Drainage	Texture	Soil depth	CaCO ₃ (%)	CEC	O.C%	Salinity (ECe)	Sodicity (ESP)	Sodicity	
P ₁	S ₁	S ₁	S ₁	S ₁	S ₁	S ₃	S ₁	S ₁	S ₁	S ₁	S ₁	S ₁	S ₃ S
P ₂	S ₁	S ₁	S ₁	S ₁	S ₁	S ₃	S ₁	S ₁	S ₁	S ₁	S ₁	S ₁	S ₃ S
P ₃	S ₁	S ₁	S ₂	S ₁	S ₁	N ₁	S ₁	S ₁	S ₁	S ₁	S ₁	S ₁	N ₁ ws
P ₄	S ₁	S ₁	S ₂	S ₁	S ₁	S ₂	S ₁	S ₁	S ₁	S ₁	S ₁	S ₂	S ₂ wsn
P ₅	S ₁	S ₁	S ₁	S ₂	S ₁	S ₂	S ₁	S ₁	S ₁	S ₁	S ₁	S ₁	S ₂ ws
P ₆	S ₁	S ₁	S ₃	S ₁	S ₂	S ₃	S ₁	S ₁	S ₁	S ₁	S ₁	S ₁	S ₃ ws
P ₇	S ₁	S ₁	S ₂	S ₂	S ₁	S ₃	S ₁	S ₁	S ₁	S ₁	S ₁	S ₁	S ₃ ws
P ₈	S ₁	S ₁	S ₃	S ₁	S ₁	N ₁	S ₁	S ₁	S ₁	S ₁	S ₁	S ₁	N ₁ ws
P ₉	S ₁	S ₁	S ₂	S ₁	S ₁	S ₁	S ₁	S ₁	S ₁	S ₁	S ₁	S ₁	S ₂ w

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

Source: Sys *et al.*, 1991 and NBSS & LUP, 1994

(Sys *et al.* 1991) and NBSS&LUP (1994). The landscape and soil requirements for these crops were matched with generated data at different limitation level: no (0), slight (1), moderate (2), severe (3), very severe (4). The number and degrees of limitations suggested the suitability class i.e., S₁- highly suitable, S₂- moderate suitable, S₃- marginally suitable, N₁- currently not suitable and N₂- not suitable of pedon for a particular crop (Sys *et al.* 1991). The potential land suitability (Table 4) sub-classes were determined after considering the improvement measures to correct these limitations (Sys *et al.*, 1991).

Results and Discussion

Soil Characteristics

The data pertaining to soil characteristics of different talukas of pedon P₁ to P₉ are presented in Table 2. The pH ranged from 7.97 to 8.27 (mean value of 8.17) indicating alkaline in reaction which might be due to proper drained association with comparative high rainfall (Deshmukh and Bapat, 1993). The E_{Ce} ranged from 3.15 to 5.07 dS m⁻¹ (mean value 4.05 dS m⁻¹) this might be due to arid and semi-arid climate, less annual rainfall, saline irrigation water, etc. These soils were tested low in organic carbon ranging from 0.42 to 0.55% (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 (Leelavathi *et al.*, 2009). The CaCO₃ content ranged from 4.40 to 6.90% (with mean value of 5.32%) indicating the highly calcareous nature of soils which might be due to impregnation of lime in the transported materials and accumulation of shells in the marine alluvial soils particularly in this district. The CEC ranged from 31.0 to 43.7 cmol (P⁺) kg⁻¹ (mean value of 36.57%). The ESP ranged from 10.9 to 17.1 (mean value 14.47) the higher value of ESP might be due to its mobility and position of profile in transect, poor drainage, shallow underground water and high Na salts. These facts corroborated by the findings of Barua (1989); Savalia, (2005) and Patel (2010). In general, the soils of Jamnagar district were alkaline in reaction, saline, highly calcareous in nature and low in organic carbon.

Soil-site suitability for Indian mustard

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 Indian mustard are given in Table 4. Pedon P₁ belongs to Lithic Troparthents and pedon P₂ belongs to Lithic Ustorthents are marginally suitable (S₃) for Indian mustard cultivation. These soils showed the limitations of wetness (soil depth), soil conservation measures like graded narrow base terrace bunds or trenches, and contour bunding should be adopted to make it suitable for Indian mustard cultivation. Pedon P₃ and pedon P₈ belongs to Lithic Ustorthents are currently not suitable (N₁) for Indian mustard cultivation. The major limitations are wetness (topography) and physical characteristics (soil depth). The major limiting factors are shallow soil depth and excessive slope which make them unfit for Indian mustard cultivation. Pedon P₄ belongs to Typic Ustochrepts are moderately suitable (S₂) for Indian mustard cultivation. The major limitations are wetness (topography), physical characteristics (soil depth) and high sodicity. On adoption agronomical measures, soil conservation like strip cropping, crop rotation, and application of gypsum could be helpful to make highly suitable for Indian mustard cultivation. Similar result was reported by Meena *et al.* (2012) in Malwa plateau of Rajasthan.

The soils associated with pedon P₅ belong to Vertic Troparthents and pedon P₉ belongs to Typic Ustochrepts are moderately suitable (S₂) for Indian mustard cultivation due to poor drainage, soil depth and topography. On adoption of corrective soil conservation measures like graded narrow base terrace bunds or trenches, contour bunding and application of green manuring should be used to make them suitable for Indian mustard cultivation. The soils associated with pedon P₆ and P₇ belong to Lithic Ustochrepts are marginally suitable (S₃) for Indian mustard cultivation. These soils showed limitation of wetness (topography and drainage) and physical characteristics (soil depth and texture). The major limitations are drainage, slope and shallow soil depth.

Conclusion

Based on the present study, it can be concluded that the soils of study area were alkaline in reaction, poor soil fertility, saline and calcareous in nature. The soils of pedon P₄ (Typic Ustochrepts), P₅ (Vertic Troparthents), P₉ (Typic Ustochrepts) are moderately suitable for Indian mustard cultivation, whereas the soils of pedon P₁ (Lithic Troparthents), P₂ (Lithic Ustorthents), P₆ (Lithic Ustochrepts) and P₇ (Lithic Ustochrepts) are marginally suitable for Indian mustard cultivation. Pedon P₃ and P₈ belongs to Lithic Ustorthents are currently not suitable for Indian mustard cultivation. Corrective measures can be used to improve the limitation factors for Indian mustard cultivation. These findings are supported with the findings of Meena *et al.* (2012) who indicated that soil depth, drainage, erosion and texture in soils of Malwa plateau in Rajasthan causes moderately suitable for Indian mustard crop.

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