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SEASONAL VARIATION IN SALINITY / SODICITY DEVELOPMENT IN SOILS OF NAVSARI DISTRICT (GUJARAT) AS INFLUENCED BY VARYING QUALITY OF IRRIGATION WATER

AMARESH DAS & S. S. ZAMBARE

Department of Soil Science, Navsari Agricultural University, Navsari (Gujarat), India

ABSTRACT

An investigation was carried out with an objective to assess the seasonal variation in the salinity / sodicity development in soils of five talukas of Navsari district (Gujarat) as influenced by varying quality of irrigation water sources in this district. Fifty seven numbers of irrigated soil samples under varying crops from five talukas i.e. Jalalpor, Navsari, Gandevi, Chikhli and Vansda of Navsari district were collected from 10/12 randomly selected villages of each talukas during pre- (May) and post-monsoon (October-November) seasons of 2010. Soil pH, EC, exchangeable cations, Organic Carbon, available N, P_2O_5 and K_2O were determined from these samples. ESP of these irrigated soils was computed. The overall results of Navsari district revealed that during pre-monsoon season about 23 per cent irrigated soils belonged to slightly saline (EC 1.0 to 2.0 dS m^{-1}) to highly saline (EC >3.0 dS m^{-1}) class and rest (77%) came under normal class while, in post monsoon season percentage under normal class increased to about 88 per cent and the rest 12 per cent soils belonged to slightly to highly saline class. With regard to ESP, about 40 and 12 per cent soils depicted high ESP (>15) in pre and post-monsoon period, respectively.

KEYWORDS: Salinity/ Sodicity Development, Irrigated Soils, Varying Water Quality, Seasonal Variation, Soil pH, EC, Exchangeable Cations, Organic Carbon, N, P_2O_5 and K_2O, ESP

INTRODUCTION

Materials and Methods

An investigation was carried out during 2010 to find out on the seasonal variation in salinity / sodicity development and fertility Status of irrigated soils in five talukas namely, Jalalpor, Navsari, Gandevi, Chikhli and Vansda of Navsari District of Gujarat as influenced by varying quality of irrigation water sources of this district. Geography and climate of Navsari district including location and overview of study area, rainfall and climate, Land use, rivers and details of water sources were already mentioned by Zambare and Das (2015). Major soils of Navsari district (except Vansda talukas) comes under *Vertisol* with *Ustert* suborder having great group *Chromustert.* Soils are deep,moderately drained, clayey (42 to 50 % clay) with good water holding capacity, medium to poor drainage with flat topography. M*ontmorillonite* is the predominant clay mineral. Parts of Vansda taluka are hilly undulating highly dissected piedmont plateau and escarpment slope are shallow with excessive relief. Soils in this area are loam to sandy loam and in some parts gravelly silty clay in texture, medium to low water holding capacity and non-calcareous with slightly acidic reaction, mixed in clay minerals, well drained and highly permeable. In this taluka major soils come under *Inceptisol* order.

Soil Sample Sites and Collection

Locations of Soil sample sites in five talukas of Navsari district were fixed nearby or in the close vicinity of different water sources as were being used as source of irrigation to different crops. Details of water sources including their sites were already mentioned by Zambare and Das (2015). In accordance with water sources total fifty seven numbers of irrigated soil samples from fifty seven villages encompassing ten to twelve randomly selected villages in each taluka of Navsari district were collected during two season *i.e* in summer (April-May) and after rainy season (October-November). Against one irrigation water source, one representative soil sample was collected for analysis in the laboratory.

Method of Soil Analysis

Soil pH and Electrical conductivity were estimated in 1:2.5 soil: water suspension by using pH-meter with glass electrode and electrical conductivity meter respectively (Gupta, 2007). Soil organic carbon was determined by following Walkley and Black (1934) rapid titration method (Piper, 1966). Soil available nitrogen was determined by following 0.32% alkaline potassium permanganate method (Subbiah and Asija, 1956). Soil available phosphorus was determined by following Spectrometric (Extraction with 0.5M $NaHCO_3$, pH 8.5) method (Olsen et al, 1954). Soil available potassium was determined by following flame photometric (Extraction with 1N NH_4OAc) method (Hanway and Heidel, 1952). Soil exchangeable sodium percentage was determined by using neutral normal ammonium acetate extraction. The exchangeable Na+ and K+ was estimated directly using flame photometer, while exchangeable Ca2+ and Mg2+ were determined by EDTA-titration method (Gupta, 2007) from the extraction of supernatant solution. The ratings for soil pH were done as suggested by SSSA (1962). The rating for soil electrical conductivity was done as referred by Seth (1967). The salt affected soils were categorized on the basis of ESP along with some other characteristics (Gupta, 2007). ESP and total exchangeable cations were computed as below. For each parameter data obtained from each taluka were subjected to statistical analyses as per need by using the methods given by Panse and Sukhatme (1985).

$$ESP = \frac{\text{Exchangeable Na (me/100g)} \times 100}{\sum \text{Exch. Cations}}$$

$$\sum \text{Exch. Cations} = \text{Exch. (Ca + Mg + Na + K)}$$

RESULTS AND DISCUSSIONS

Quality Parameters of Irrigated Soil

Soil pH & EC

$pH_{2.5}$ of irrigated soils of Navsari district were found to vary from 6.19 to 8.41 (slightly acidic to moderately alkaline) with a mean value of 7.46 in pre-monsoon season and the corresponding values were 6.12 to 8.12 (slightly acidic to moderately alkaline) and 7.15, respectively in post-monsoon season. About 38.59 per cent samples came under mildly alkaline (pH 7.4 to 7.8), 22.80 per cent moderately alkaline (7.9 to 8.4) and, 38.61 per cent slightly acidic to neutral class in pre-monsoon season, while in post monsoon season the corresponding parameters were 26.31, 3.50 and 70.16 per cent, respectively. Soil reaction of pre-monsoon samples of Jalalpore, Navsari, Gandevi, Chikhli and Vansada talukas (Table 1, 2

and 3) varied respectively from neutral to moderately alkaline, mildly to strongly alkaline, mildly to moderately alkaline, slightly acidic to moderately alkaline and slightly acidic to mildly alkaline with the corresponding mean values of 7.53, 7.86, 7.78, 7.13 and 6.96 respectively. However, the corresponding values for post – monsoon period were neutral to mildly alkaline, neutral to moderately alkaline, neutral to moderately alkaline, slightly to mildly alkaline and slightly acidic to mildly alkaline, respectively with mean values of 7.26, 7.50, 7.37, 6.96 and 6.65 respectively. The mean soil pH of irrigated soils of Navsari district varied from 6.96 to 7.86 and from 6.65 to 7.50 in pre and post-monsoon period respectively, indicating higher pH value in pre-monsoon samples which might be due to leaching losses of salts and sodium ion from the exchange complex during high rainfall in monsoon leading to decrease in soil pH during post-monsoon season or use of poor quality water containing higher quantum of carbonates, bicarbonates and sodium during pre- monsoon period. With respect to mean soil acidity talukas can be placed in the order: Navsari > Gandevi > Jalalpor > Chikhli > Vansda for both the seasons (Table 1, 2 and 3). Results were in good agreement with those obtained by Yadav *et al.* (2007).,Singh *et al*. (2008) and Jena *et al.* (2010).

$EC_{2.5}$ of irrigated soils varied from 0.21 to 12.40 (dS m^{-1}) with a mean value of 1.16 (dS m^{-1}) in pre-monsoon season and from 0.17 to 6.30 (dS m^{-1}) with mean value of 63 (dS m^{-1}) post-monsoon season (Table 1, 2 and 3). So far as development of salinity is concerned, about 77 and 23 per cent samples belonged to normal (EC <1.0 dS m^{-1}) and slightly (EC 1.0 to 2.0 dS m^{-1}) to highly saline class (EC >3.0 dS m^{-1}) respectively in pre-monsoon season while, in post monsoon season per cent under normal class increased to 87.71 with 12.29 per cent samples belonging to slightly to highly saline class. The Increase in $EC_{2.5}$ of irrigated soils of Navsari district might be due to accumulation of ions (cations and anions) in surface soil through applied irrigation water of varying quality at higher frequency. In case of individual taluka, it was observed (Table 1, 2 and 3) that during pre-monsoon period, soils of Jalalpore, Navsari, Gandevi, Chikhli and Vansada showed EC(dS m^{-1}) ranging from 0.37 to 6.6 (normal to highly saline), 0.24 to 1.96 (normal to tending to become saline), 0.21 to 12.4 (normal to very high saline), 0.29 to 1.67 (normal to tending to become saline) and 0.21 to 3.60 (normal to highly saline) respectively with mean values of 2.15, 0.64, 1.48, 0.86 and 0.80 dS m^{-1} respectively. However, the above values for post – monsoon period were 0.34 to 2.2 dS m^{-1} (normal to saline nature), 0.21 to 1.30 dS m^{-1} (indicating normal), 0.23 to 6.3 dS m^{-1} (normal to very high saline), 0.28 to 0.88 dS m^{-1} (normal in reaction) and 0.17 to 1.03 (normal) respectively with corresponding mean values of 0.88, 0.49, 0.87, 0.54 and 0.42 dS m^{-1}. Mean soil $EC_{2.5}$ associated with each taluka of Navsari district and Navsari district as a whole indicated that mean soil $EC_{2.5}$ varied from taluka to taluka and followed the order: Jalalpor > Gandevi > Chikhli > Vansda > Navsari in pre and Jalalpor > Gandevi > Chikhli > Navsari > Vansda in post-monsoon season (Table 1, 2 and 3). In case of Jalalpor and Gandevi taluka, positive significant correlations (r=0.899** and 0.856** in pre and post-monsoon in Jalalpor, and r = 0.808** and 0.662* in pre and post-monsoon in Gandevi taluka) were observed between water EC and irrigated soil EC in soil samples of both the seasons indicating that with increase in water EC, salinity of irrigated soil increased. Further, in Navsari and Chikhli taluka, significant correlation (r=0.613* and 0.678* in Navsari and Chikhli respectively) was observed between water pH and irrigated soil EC in post-monsoon samples. That at least 23 and 12 per cent irrigated soils in pre and post monsoon period respectively became slightly to highly saline due to irrigation with varying quality of water resources. Thus, it is implied that farmers should not use these water sources directly or they may use these after dilution or may use gypsum either with

irrigation water or on soil in requisite quantity for sustaining soil health and crop production. The decrease in soil salinity during post-monsoon period was as a result of leaching of soluble salts during rainy season from surface soil. Similar observations were also recorded by Singh *et al*. (2008) and Parmar and Patel (2010)

Exchangeable Sodium Percentage (ESP)

ESP of irrigated soils varied from 9.33 to 50.23 with a mean value of 16.53 in pre and 7.68 to 24.19 with a mean value of 11.71 in post-monsoon season, indicating comparatively higher ESP in pre-monsoon season which might be due to higher Na^+ in the exchange complex that had arisen as a result of use of poor quality (saline / sodic) water (Table 1, 2 and 3). About 60 and 40 per cent irrigated soils came respectively under low ESP (<15) and high ESP (>15) categories in pre-monsoon season while, the corresponding values for post monsoon season were about 88 and 12 per cent, respectively in Navsari district. Soil ESP was positively and significantly correlated with EC, SAR and RSC of irrigation waters in all the talukas. >98 per cent irrigated soils for both the seasons came under sodic soil, when ESP 8 was considered as threshold level of sodicity problem (Table 1, 2 and 3). Thus, farmer should get their irrigation water analyzed in order to know their suitability in relation to soil and crop to avoid any soil sodicity hazard. In case of individual taluka, it was observed that during pre-monsoon period soil ESP of Jalalpore, Navsari, Gandevi, Chikhli and Vansada varied from 14.00 to 37.95, 11.40 to 22.86, 9.54 to 50.23, 9.33 to 17.73 and 10.37 to 18.29 respectively with mean values of 25.41, 16.04, 16.40, 13.38 and 12.67 respectively (Table 1, 2 and 3). However, the above values for post – monsoon period were 10.35 to 24.19, 8.42 to 14.45, 7.68 to 16.77, 8.09 to 11.17 and 8.34 to 13.97 respectively with corresponding mean values of 17.03, 11.67, 9.97, 9.76 and 10.84. Soils of Jalalpor taluka indicated appreciable to high development of sodicity problem (ESP >15) which might be due to clayey texture and poor drainage condition. Here, a significant positive correlation (r= 0.710*) was found between EC of various irrigation waters and the corresponding soil ESP indicating sharp increase in soil ESP with salinity of water. However, sodicity of irrigated soils declined slightly in post-monsoon period as a result of washing out of part of Na+ ion from the exchange complex due to rainfall. The results clearly indicated that farmers should not use such water having very high SAR, EC and RSC as irrigation source for raising their crops without taking any precautionary measure to overcome the possible adverse effect of soil sodicity. Similar kind of opinion was also expressed by Singh and Totawat (1994) and Vaidya *et al.* (2007).

Soils of Navsari talukas indicated saline nature due to presence of excess soluble salts into soil. Gandevi soils were alkali to saline in nature due to presence of excess of soluble salts and exchangeable Na^+ and Chikhli soils indicated saline and sodic nature due to presence of excess of soluble salts in soil in both the seasons. In case of Vansada soils, development of soil salinity or sodicity in this taluka would be very less under irrigated condition because of light textured soil. Thus, much precautionary measures would not be needed to overcome the adverse effect on soil. In Gandevi talukas positive significant correlations (r = 0.861** for pre-monsoon and 0.722** for post-monsoon) was observed (Table 61 and 62) between water EC and irrigated soil ESP in both the seasons indicating that with increase in water EC, the ESP of irrigated soil increased. Harangaon village of Chikhli talukas recorded the high RSC value (7.00 and 4.50) of irrigation water in both seasons and it correlated significantly (r = 0.713*) with soil ESP during post-monsoon season.

Soil Organic Carbon

The organic carbon content varied from low to high in all the talukas in both the seasons. In pre-monsoon soils it varied from 0.47 to 1.95 (%) with a mean value of 1.00 (%) and in post-monsoon season the value ranged from 0.36 to 1.49 (%) with a mean value of 0.77 (%) in the district (Table 4, 5 and 6). In case of taluka - wise soils, it was observed that during pre-monsoon period soils of Jalalpore, Navsari, Gandevi, Chikhli and Vansada showed OC from 0.675 to 1.755 (%) (medium to very high), 0.60 to 1.95 (%) (medium to very high), 0.855 to 1.815 (%) (high to very high), 0.480 to 1.020 (%) (low to very high) and 0.465 to 1.740 (%) (low to very high) respectively with mean values of 1.011, 0.993, 1.192, 0.825 and 0.944 (%) respectively. However, the above values for post – monsoon period were 0.555 to 1.245 (%) (medium to very high), 0.390 to 0.990 (%) (medium to high), 0.615 to 1.485(%),0.360 to 1.050 (%) and 0.405 to 1.035 (%) (low to very high) respectively with corresponding mean values of 0.859, 0.663, 0.905, 0.683 and 0.764 (%) (Table 4, 5 and 6). No appreciable difference was observed in organic carbon content as to varying seasons in Jalalpor, Navsari and Chikhli talukas (Table 4, 5 and 6). However, in some soils the value either slightly increased or decreased in post-monsoon period which might be due to the difference in organic matter addition by the farmers and rate of decomposition of organic matter. The descending orders of different talukas mean soil organic carbon (%) is as below: Gandevi > Jalalpor > Navsari > Vansda > Chikhli during pre-monsoon period while, Gandevi >Jalalpor > Vansda > Chikhli > Navsari in post-monsoon season respectively (Table 4, 5 and 6). Similar findings were also reported by Hundekar *et al*. (2001), Yadav (2007) and Parmar and Patel (2010).

Soil Available Nitrogen

The available nitrogen content in pre-monsoon soils of this district varied from 117.04 to 439.04 kg ha^{-1} (low to medium) with a mean value of 271.14 kg ha^{-1} and 142.68 to 360.64 kg ha^{-1} (low to medium) with a mean value of 203.09 kg ha^{-1}, respectively in post-monsoon season exhibiting low to medium status (Table 4, 5 and 6). Talukas with respect to soil available N may be placed as: Gandevi > Vansda > Navsari > Chikhli > Jalalpor for pre-monsoon period and Jalalpor > Gandevi > Navsari > Vansda > Chikhli for post-monsoon period. Reason for low to medium status of nitrogen might be due to their 'low to medium' status of native organic carbon which played a pivotal role in the mineralization of nitrogen in soils (Table 4, 5 and 6). As irrigation water contained very less amount of nitrate-nitrogen, contribution of nitrogen by water to soil was very negligible. These results were in confirmative of the finding of Singh and Bishnoi (2001) and Jena *et al*. (2010).

Soil Available Phosphorus

The available phosphorus content in pre-monsoon soils of this district varied from 12.73 to 230.01 kg ha^{-1} with a mean value of 82.37 kg ha^{-1} and 7.04 to 116.25 kg ha^{-1} with a mean value of 51.81 kg ha^{-1} in post-monsoon season exhibiting low to high status (Table 4, 5 and 6). Talukas with respect to soil available phosphorus may be placed as: Gandevi > Chikhli > Vansda > Jalalpor > Navsari for pre-monsoon period and for post-monsoon period as Chikhli > Gandevi > Vansda > Jalalpor > Navsari (Table 4, 5 and 6). The higher content of available phosphorus under Gandevi taluka might be due to build up of phosphorus in soil due to continuous application of inorganic fertilizer and addition of higher organic biomass with their subsequent decomposition in soil. The results were fully supported by the finding of Jena

et al. (2010) and Parmar and Patel (2010).

Soil Available Potassium

The available potassium content in pre-monsoon soils of this district varied from 152.35 to 429.40 kg ha^{-1} (medium to high) with a mean value of 262.29 kg ha^{-1} and from 171.95 to 456.50 kg ha^{-1} (medium to high) with a mean value of 282.34 kg ha^{-1} in post-monsoon season exhibiting medium to high status (Table 4, 5 and 6). Comparatively higher availability of K_2O in post-monsoon season might be due to transformation of K^+ from clay lattices to exchange sites or in solution due to rain. Soil available K_2O with respect to talukas may be placed as: Jalalpor > Gandevi > Navsari > Chikhli > Vansda for pre-monsoon period and Jalalpor > Gandevi > Navsari > Chikhli > Vansda for post-monsoon season (Table 4, 5 and 6). Similar results have been reported by Kahlon and Khera (2008) and Jena *et al*. (2010).

CONCLUSIONS

As irrigation with varying quality of waters of Navsari district during pre-monsoon period converted 23 per cent good soil to 'slightly to highly saline' and about 40 per cent good soil to 'sodic soil' and during post-monsoon period 12 per cent to ' slightly to highly saline and 12 per cent to sodic soils, application of gypsum either with such waters or on such soils to the requisite quantum is a must for sustaining soil/ crop health ,possible higher crop yield and maintaining environmental stability.

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Table 1: $Ph_{2.5}$, $EC_{2.5}$ (dSm^{-1}), Exch. Na, Total Exch. Cations and ESP (%) of Irrigated Soils of Jalalpor and Navsari Taluka in Pre and Post-monsoon Seasons

Jalalpor Taluka										
Village Name	Pre-monsoon Samples					Post-monsoon Samples				
	$pH_{2.5}$	$EC_{2.5}$ ($dS\ m^{-1}$)	Exch. Na	∑ Exch. Cations ($me\ L^{-1}$)	ESP (%)	$pH_{2.5}$	$EC_{2.5}$ ($dS\ m^{-1}$)	Exch. Na	∑ Exch. Cations ($Me\ L^{-1}$)	ESP (%)
Parsoli	**7.13**	1.25	8.46	**32.87**	25.73	7.05	0.53	5.21	29.81	17.47
Karankhat	8.10	0.56	7.16	28.26	25.33	7.22	0.41	6.73	**34.98**	19.23
Arsan	7.72	**0.37**	6.99	31.16	22.43	7.46	**0.34**	4.77	33.38	14.28
Kolasana	7.15	1.90	5.47	29.34	18.64	**7.01**	0.46	6.51	32.99	13.73
Dabhel	7.19	2.00	**3.69**	26.34	**14.00**	7.21	1.19	**3.25**	28.63	**10.35**
Sarav	7.53	1.21	4.77	26.50	18.00	7.20	0.87	3.91	30.89	12.65
Kharsad	**8.20**	0.92	**8.68**	27.25	31.85	**7.69**	0.38	6.07	32.82	18.49
Sultanpur	7.48	3.90	8.15	25.31	32.20	7.25	1.31	5.64	**28.35**	19.89
Athan	7.55	2.80	7.81	27.90	27.99	7.37	1.12	**7.08**	29.47	20.02
Eru	7.31	**6.60**	8.24	**21.71**	**37.95**	7.18	**2.20**	6.93	28.64	**24.19**
Range	**7.13-8.20**	**0.37-6.60**	**3.69-8.68**	**21.71-32.87**	**14.00-37.95**	**7.01-7.69**	**0.34-2.20**	**3.25-7.08**	**28.35-34.98**	**10.35-24.19**
Mean	**7.53**	**2.15**	**6.94**	**27.66**	**25.41**	**7.26**	**0.88**	**5.61**	**30.99**	**17.03**
S.D	**0.37**	**1.89**	**1.72**	**3.10**	**7.38**	**0.19**	**0.59**	**1.31**	**2.37**	**4.18**
Navsari taluka										

Vejalpor	**7.33**	0.48	3.82	27.12	14.08	7.21	0.42	5.20	33.17	11.67
Ambalpur	7.55	0.55	2.82	24.72	**11.40**	7.36	0.31	3.04	27.05	9.23
Talada	7.85	**0.24**	3.26	24.14	13.50	7.76	**0.21**	3.69	26.36	13.99
Vata	7.79	0.75	5.64	30.32	18.60	7.69	0.67	3.48	27.43	11.82
Tarsadi (I)	8.16	0.68	3.48	25.49	13.65	7.65	0.52	3.91	29.45	13.27
Tarsadi (II)	8.19	0.44	3.18	24.46	13.00	8.01	0.37	4.13	28.58	9.90
Dandeshwar	8.10	0.26	**2.68**	**23.07**	11.61	7.48	0.32	3.58	30.04	**8.42**
Toli	**8.41**	0.27	4.77	26.85	17.76	**8.12**	0.22	**6.29**	**35.60**	13.66
Navatalav	7.60	0.38	3.69	26.14	14.11	7.51	0.43	3.36	29.90	11.23
Khadsupa	7.82	0.70	5.64	27.92	20.20	7.6	0.58	3.04	28.30	10.74
Adada	7.64	**1.96**	**7.38**	**32.28**	**22.86**	**6.66**	**1.30**	**2.60**	**26.24**	**14.45**
Pratapor	7.95	1.00	6.24	29.70	21.74	7.03	0.62	3.73	31.70	11.76
Range	**7.33-8.41**	**0.24-1.96**	**2.68-7.38**	**23.07-32.28**	**11.40-22.86**	**6.66-8.12**	**0.21-1.30**	**2.60-6.29**	**26.24-35.60**	**8.42-14.45**
Mean	**7.86**	**0.64**	**4.38**	**26.85**	**16.04**	**7.50**	**0.49**	**3.83**	**29.48**	**11.67**
S.D	**0.31**	**0.47**	**1.51**	**2.78**	**3.99**	**0.40**	**0.29**	**1.00**	**2.84**	**1.91**

Table 2: $pH_{2.5}$, $EC_{2.5}$ (dS m^{-1}), Exch. Na, Total Exch. Cations and ESP of Irrigated Soils of Gandevi and Chikhli Taluka in Pre and Post-monsoon Seasons

Gandevi Taluka										
Village Name	**Pre-monsoon Samples**					**Post-monsoon Samples**				
	$pH_{2.5}$	**$EC_{2.5}$ (dS m^{-1})**	**Exch. Na**	**∑ Exch. Cations (me L^{-1})**	**ESP (%)**	**$pH_{2.5}$**	**$EC_{2.5}$ (dS m^{-1})**	**Exch. Na**	**∑ Exch. Cations (me L^{-1})**	**ESP (%)**
Gadat-I	7.91	**0.21**	4.34	29.24	14.84	7.23	0.25	3.04	**36.26**	8.38
Manekpor	7.7	0.45	**3.04**	31.86	**9.54**	7.15	0.33	3.26	34.90	9.34
Pipal-dhara	7.93	0.26	3.25	**24.33**	13.35	7.39	**0.23**	3.47	34.56	10.04
Dhanori	7.91	0.51	4.55	30.66	14.48	7.56	0.39	3.04	32.88	9.24
Desad	**7.48**	0.79	4.34	**38.92**	11.15	**7.13**	0.39	**2.39**	31.11	**7.68**
Dhakwada	7.75	0.77	4.99	32.97	15.18	7.41	0.67	3.25	35.27	9.21
Bhesla	7.68	**12.4**	**8.72**	27.36	**50.23**	7.21	**6.3**	**3.91**	**23.31**	**16.77**
Nanikarod	**8.15**	0.69	5.86	37.82	15.49	**7.79**	0.54	3.47	35.51	9.77
Salej-I	7.78	0.26	3.68	26.78	13.74	7.31	0.31	3.26	31.78	10.25
Hajrai	7.72	0.85	5.42	33.00	16.42	7.4	0.42	3.48	35.24	9.87
Gadat-II	7.76	0.31	3.26	26.24	12.42	7.35	0.25	3.25	29.98	10.84
Salej-II	7.55	0.27	3.47	34.98	9.91	7.46	0.33	3.47	30.99	8.19
Range	**7.48-8.15**	**0.21-12.4**	**3.04-8.72**	**24.33-38.92**	**9.54-50.23**	**7.13-7.79**	**0.23-6.3**	**2.39-3.91**	**23.31-36.26**	**7.68-16.77**
Mean	**7.78**	**1.48**	**4.58**	**31.18**	**16.40**	**7.37**	**0.87**	**3.27**	**32.64**	**9.97**
S.D	**0.18**	**3.45**	**1.59**	**4.61**	**10.88**	**0.19**	**1.72**	**0.36**	**3.61**	**2.33**
Chikhli taluka										
Tankal	7.46	0.67	4.34	32.69	13.27	7.31	0.53	**3.04**	32.01	9.49
Vanzna	6.70	**0.29**	3.25	27.93	11.63	7.08	**0.28**	3.47	32.79	10.58
Harangam	**8.20**	0.69	5.24	29.54	**17.73**	7.47	0.49	4.13	39.33	**11.17**
Sadadwel	6.54	1.16	3.70	26.59	13.91	**6.36**	0.67	4.34	**28.60**	10.50
Khudwel	7.25	**1.67**	4.99	32.86	15.18	6.90	0.86	3.68	34.98	10.52
Agasi	6.66	0.95	3.26	27.90	11.68	6.50	0.48	3.47	42.87	**8.09**
Aswani	**6.35**	1.21	3.69	27.90	13.22	6.43	**0.88**	3.69	39.45	9.35
Khergam	6.74	0.77	3.25	**25.98**	12.50	6.58	0.51	3.69	40.24	9.16
Vaduwhabeda	6.80	0.98	**3.04**	32.58	**9.33**	7.01	0.64	4.12	42.07	8.49
Bodvank	7.71	0.49	3.69	30.23	12.20	7.36	0.29	**4.55**	41.91	10.85
Alipor	8.01	0.54	**6.07**	**36.51**	16.62	**7.55**	0.32	4.12	**44.67**	9.22
Range	**6.35-.20**	**0.29-1.67**	**3.04-6.07**	**25.98-36.51**	**9.33-17.73**	**6.36-7.55**	**0.28-0.88**	**3.04-4.55**	**28.60-44.67**	**8.09-11.17**
Mean	**7.13**	**0.86**	**4.05**	**30.06**	**13.38**	**6.96**	**0.54**	**3.85**	**38.08**	**9.76**
S.D	**0.63**	**0.39**	**0.99**	**3.24**	**2.39**	**0.44**	**0.21**	**0.44**	**5.19**	**1.01**

Table 3: $pH_{2.5}$, $EC_{2.5}$ (dS m^{-1}), Exch. Na, Total Exch. Cations and ESP of Irrigated Soils of Vansda Taluka in Pre and Post-monsoon Seasons

Village Name	Pre-monsoon Samples					Post-monsoon Samples				
	$pH_{2.5}$	$EC_{2.5}$ (dS m^{-1})	Exch. Na	∑ Exch. Cations (me L^{-1})	ESP (%)	$pH_{2.5}$	$EC_{2.5}$ (dS m^{-1})	Exch. Na	∑ Exch. Cations (me L^{-1})	ESP (%)
Rajpor	7.28	0.93	3.04	**22.69**	13.39	7.12	0.75	5.64	42.96	13.12
Doldha	7.05	0.38	3.03	29.12	10.40	6.89	0.31	5.42	**47.05**	10.31
Lakhawadi	**6.19**	0.31	2.82	26.04	10.82	6.25	0.24	4.34	**30.05**	8.44
Labhawal	6.20	0.28	3.39	25.75	13.16	**6.12**	0.19	5.08	43.71	11.62
Kataswel	**7.75**	0.74	3.99	25.57	15.60	**7.56**	0.43	4.77	43.26	11.02
Nanivalzar	6.45	**3.60**	**4.56**	24.92	**18.29**	6.34	**1.03**	**5.64**	40.35	**13.97**
Pindhabari	6.37	0.66	3.04	36.41	11.71	6.42	**0.17**	**4.34**	37.05	**8.34**
Gangpur	7.19	0.83	**2.82**	22.92	12.30	7.06	0.27	4.74	40.18	10.79
Kawadge	7.10	0.67	3.04	29.30	**10.37**	6.30	0.32	4.56	38.01	9.99
Rangpur	7.57	0.43	3.91	32.07	12.19	6.89	0.34	4.78	42.37	11.28
Dholumber	7.01	0.54	3.91	32.49	12.03	6.35	0.67	4.99	36.17	10.79
Vandervela	7.33	**0.21**	4.34	**36.77**	11.80	6.54	0.28	4.55	39.79	10.43
Range	**6.19-7.75**	**0.21-3.60**	**2.82-4.56**	**22.69-36.77**	**10.37-8.29**	**6.12-7.56**	**0.17-1.03**	**4.34-5.64**	**30.05-47.05**	**8.34-13.97**
Mean	**6.96**	**0.80**	**3.49**	**28.67**	**12.67**	**6.65**	**0.42**	**4.90**	**40.07**	**10.84**
S.D	**0.53**	**0.91**	**0.62**	**4.86**	**2.28**	**0.44**	**0.26**	**0.46**	**4.42**	**1.62**

Table 4: Soil Available Nutrients in Soils of Jalalpor and Navsari Taluka in Pre and Post-Monsoon Seasons

Jalalpor Taluka								
Village Name	Pre-monsoon Samples (kg ha^{-1})				Post-monsoon Samples (kg ha^{-1})			
	OC (%)	N	P_2O_5	K_2O	OC (%)	N	P_2O_5	K_2O
Parsoli	1.140	**338.68**	**156.32**	**221.30**	0.945	**360.64**	68.72	**239.70**
Karnkhat	0.765	250.88	45.60	345.05	0.780	227.24	67.58	361.65
Adsan	**1.755**	257.15	94.23	315.21	**1.245**	213.24	**105.00**	321.00
Kolhasna	0.780	197.56	36.12	248.21	0.990	205.40	34.60	253.25
Dabel	1.215	260.28	78.03	321.00	1.020	290.08	65.30	330.35
Sarav	0.885	216.38	62.91	321.35	0.675	**177.18**	44.16	361.65
Kharsad	0.915	224.22	39.73	260.00	0.810	189.72	34.99	280.25
Sultanpur	0.840	232.06	42.42	306.20	0.855	238.33	45.79	321.00
Athan	1.140	337.12	61.72	**376.24**	0.720	236.76	33.39	**402.30**
Eru	**0.675**	**170.91**	**12.73**	290.12	**0.555**	213.24	**14.61**	293.90
Range	**0.675-1.755**	**170.91-338.68**	**12.73-156.32**	**221.30-376.24**	**0.555-1.245**	**177.18-360.64**	**14.61-105.00**	**239.70-402.30**
Mean	**1.011**	**248.52**	**62.98**	**300.47**	**0.859**	**235.18**	**51.41**	**316.51**
S.D	**0.317**	**54.47**	**40.04**	**46.64**	**0.198**	**53.861**	**25.693**	**50.98**
Navsari taluka								
Bijalpur	1.425	**370.04**	61.81	**345.14**	**0.990**	**326.14**	37.13	**402.30**
Ambalpur	1.215	316.73	97.18	266.80	0.765	227.36	45.79	280.35
Telala	**1.950**	225.79	**17.72**	215.02	**0.390**	177.18	**15.12**	222.60
Vata	0.780	**117.18**	42.95	285.00	0.495	**163.07**	25.48	293.90
Tarsadi I	**0.600**	330.84	20.74	**170.35**	0.585	203.84	19.24	**212.60**
Tarsadi II	0.810	208.54	27.34	255.01	0.450	185.02	23.54	266.80
Dandeshwar	0.810	239.90	35.08	215.24	0.615	254.01	27.12	226.15

Table 4: Cond.,

Toli	0.825	247.74	74.63	280.12	0.585	189.72	43.35	293.90
Navatalav	1.065	330.84	**127.1**	325.25	0.840	208.54	**69.35**	334.55
Khadsupa	0.675	255.58	57.98	281.08	0.675	180.32	39.01	293.90
Adodha	0.780	241.47	97.18	260.25	0.825	188.16	42.37	280.35
Pratapur	0.990	315.16	37.69	235.95	0.750	214.81	39.41	253.25
Range	**0.600-1.950**	**117.18-370.04**	**17.72-127.10**	**170.35-345.14**	**0.390-0.990**	**163.07-326.14**	**15.12-69.35**	**212.60-402.30**
Mean	**0.993**	**266.65**	**58.12**	**261.27**	**0.663**	**209.85**	**35.57**	**280.05**
S.D	**0.381**	**69.419**	**34.708**	**48.31**	**0.177**	**44.171**	**14.722**	**52.34**

Table 5: Soil Available Nutrients in Soils of Gandevi and Chikhli Taluka in Pre and Post-Monsoon Seasons

Gandevi Taluka								
Village Name	**Pre-monsoon Samples (kg ha^{-1})**				**Post-monsoon Samples (kg ha^{-1})**			
	OC (%)	**N**	**P_2O_5**	**K_2O**	**OC (%)**	**N**	**P_2O_5**	**K_2O**
Gadat-I	0.900	235.20	54.72	251.25	1.015	189.72	27.04	266.80
Manekpor	1.600	**439.04**	122.08	315.02	1.260	**285.37**	93.15	348.10
Pipaldhara	**0.855**	260.28	53.64	**185.02**	0.675	221.08	**26.53**	**199.05**
Dhanori	1.335	395.13	144.42	253.25	0.780	257.15	95.22	280.35
Desad	1.005	254.01	**40.84**	205.21	**0.615**	167.77	33.99	239.70
Dhakwada	**1.815**	365.34	84.33	239.70	0.975	266.56	48.51	226.15
Bhesla	0.990	274.40	46.13	**429.40**	0.765	202.27	27.58	**442.95**
Nanikarod	1.290	321.44	**191.03**	348.10	1.130	217.95	**106.25**	375.20
Salej-I	0.960	250.88	154.32	293.90	0.690	172.48	67.80	361.65
Hajrai	1.530	310.46	156.99	226.15	**1.485**	277.53	59.30	253.25
Gadat-II	1.035	280.67	167.84	253.25	0.945	163.07	61.90	266.80
Salej-II	0.990	**199.13**	105.54	265.02	0.825	**145.82**	56.72	280.55
Range	**0.855-1.815**	**199.13-439.04**	**40.84-191.03**	**185.02-429.40**	**0.615-1.485**	**145.82-285.37**	**26.53-106.25**	**199.05 - 442.95**
Mean	**1.192**	**298.83**	**110.15**	**272.11**	**0.905**	**213.89**	**58.66**	**295.05**
S.D	**0.315**	**70.525**	**53.247**	**66.91**	**0.270**	**48.289**	**27.959**	**71.57**
Chikhli taluka								
Takal	0.795	254.01	103.13	245.05	0.690	166.20	92.80	253.25
Vanzna	0.880	219.52	118.35	275.02	0.810	155.23	85.24	293.90
Harangaon	0.975	227.36	82.60	339.20	**1.050**	170.91	47.43	402.30
Sadedwel	0.825	**370.04**	122.08	280.35	0.585	**216.38**	51.84	321.00
Khudwel	**1.020**	**117.18**	**141.16**	**418.02**	0.750	147.39	**96.25**	**456.50**
Agasi	0.850	293.21	117.74	185.50	0.615	188.16	78.74	199.05
Aswani	0.990	222.65	90.13	225.02	0.675	175.61	52.94	239.70
Khergam	0.630	318.30	**12.73**	206.02	0.555	164.64	**19.24**	212.00
Vaduwhabeda	0.780	280.67	26.32	**152.35**	0.735	181.88	31.28	**171.95**
Kodwak	0.855	283.80	132.80	226.15	0.690	**145.82**	52.94	253.25

Alipor	**0.480**	260.28	35.60	212.60	**0.360**	167.77	37.13	239.70
Range	**0.480-1.020**	**117.18-370.04**	**12.73-141.16**	**152.35-418.02**	**0.360-1.050**	**145.82-216.38**	**19.24-96.25**	**171.95-456.50**
Mean	**0.825**	**258.82**	**89.33**	**251.39**	**0.683**	**170.91**	**58.71**	**276.60**
S.D	**0.159**	**64.90**	**45.01**	**74.81**	**0.171**	**20.01**	**25.87**	**86.83**

Table 6: Soil Available Nutrients in Soils of Vansda Taluka in Pre and Post-monsoon Seasons

Village Name	Pre-monsoon Samples (kg ha-1)				Post-monsoon Samples (kg ha-1)			
	OC (%)	N	P_2O_5	K_2O	OC (%)	N	P_2O_5	K_2O
Rajpur	0.735	269.69	175.45	**306.02**	0.795	192.86	83.26	**334.55**
Doldha	1.095	323.00	**230.01**	185.50	**1.035**	**266.56**	65.30	199.05
Lakhawadi	0.990	225.79	44.53	260.35	0.735	170.91	21.29	280.35
Labhawal	**1.740**	376.32	17.22	212.60	0.825	211.68	**7.04**	226.15
Kataswel	**0.465**	**399.84**	**16.72**	**175.06**	**0.405**	216.38	9.01	199.05
Nanewaljar	0.915	**172.48**	67.34	248.35	0.930	**142.68**	39.01	266.80
Pindhabari	0.915	290.08	91.29	263.05	1.005	156.80	51.84	280.35
Gangpur	1.050	268.12	82.60	275.00	0.810	186.59	49.58	293.90
Kawadge	1.080	249.31	68.46	225.26	0.690	181.88	76.24	239.70
Rangpur	0.675	258.72	104.93	206.34	0.735	194.43	**116.25**	212.60
Dholumber	1.200	275.96	38.21	176.35	0.750	186.59	37.13	**185.50**
Vandervela	0.465	227.36	126.47	246.54	0.450	152.09	106.24	266.80
Range	**0.465-1.740**	**172.48-399.84**	**16.72-230.01**	**175.06-306.02**	**0.405-1.035**	**142.68-266.56**	**7.04-116.25**	**185.50-334.55**
Mean	**0.944**	**278.06**	**88.60**	**231.70**	**0.764**	**188.29**	**55.18**	**248.73**
S.D	**0.348**	**63.585**	**63.878**	**41.73**	**0.191**	**33.374**	**35.546**	**45.62**