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Assessment of physico-chemical properties of soil from different blocks of Jhunjhunu district, Rajasthan

Neha Kumari, Anurag Kumar Singh, Shivani Agarwal and Dr. Tarence Thomas

Abstract
An experiment was conducted in Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, SHUATS, Prayagraj during 2020-21 to assess the physico-chemical properties of Soil in different blocks of Jhunjhunu district, Rajasthan, India. Depth wise soil samples were collected from nine villages at 0-15, 15-30 and 30-45 cm. Total 27 samples were selected for analysis. The results revealed that soil color varied from dark brown to very dark brown, light brownish grey to yellowish brown and light yellowish brown to Dark greyish brown. The soil color (wet condition) varied from very dark greyish brown to Dark yellowish brown, yellowish brown to brownish yellow and dark brown. Bulk and Particle densities of these soils varied from 1.04 to 1.29 Mg m^{-3} and 1.60 to 2.46 Mg m^{-3}. The pore space (%) varied from 30.22 to 54.50%. The water holding capacity (%) varied from 37.49 to 64.66%. The texture was dominantly sandy loam. Soil pH varied from 7.02 to 9.22. The Electrical Conductivity ranged from 0.21 to 0.39 dS m^{-1} and the maximum value was recorded in Ajeetpura village. The value of total Organic Carbon (%) was varied from 0.31 to 0.80%. The Available nitrogen content in the soil was varied from 150 to 277 kg ha^{-1} and nitrogen content was found low in all the entire's farmer's field. The Available Phosphorus content was found in between 15.20 to 26.35 kg ha^{-1}. The Available Potassium content in the soil was varied from 109 to 245 kg ha^{-1} and the potassium was found medium on the surface horizon and decreased with increased in soil depths. The Exchangeable Calcium content in the soil varied from 2.45 to 5.70 cmol (p^+) kg^{-1} and was found in the sufficient amount. The Exchangeable Magnesium content was varied from 2.25 to 3.70 cmol (p^+) kg^{-1}. The amount of Sulphur content in the varied from 21 to 29 kg ha^{-1} and was found to be in deficient amount. The results indicated that soils are good for cultivation of various crops. Farmers are required to maintain Soil Health Card which helps them to adopt suitable management practices and provide proper nutrition to soil.

Keywords: Physico-chemical properties, soil health card, N-P-K, Jhunjhunu district

Introduction
Soil is a natural body comprised of solids (minerals and organic matter), liquid, and gases that occurs on the land surface, occupies space, and is characterized by one or both of the following: horizons, or layers, that are distinguishable from the initial material as a result of additions, losses, transfers, and transformations of energy and matter or the ability to support rooted plants in a natural environment. Soil has either inherent and dynamic properties, or qualities (Balasubramanian, 2017) [1]. Soil is the most vital natural resource, can be termed as 'Soul of Infinite Life' and it is the exclusive source of infinite living organisms which supports the life of crop plants as a medium of growth along with providing nutrients, air and water (Saxena *et al.,* 2021) [17]. Soil health is the "state of the soil being in sound physical, chemical, and biological condition, having the capability to sustain the growth and development of land plants" (Gupta *et al.,* 2019) [9]. Physical properties of soil are mainly controlled by the soil matrix. It plays an important role in determining land suitability for agricultural, environmental and engineering uses. The supporting capability; movement, retention and availability of water and nutrients to plants; ease in penetration of roots, and flow of heat and air directly associated with physical properties of the soil. Physical properties analysis generally includes simple, fast and low-cost methodologies. It includes soil texture, bulk density, particle density, porosity, water holding capacity, specific gravity and soil color (Singh *et al.,* 2020) [19]. Chemical properties of soil are related to properties that directly affect plant nutrition. Plants need an adequate supply of nutrients to grow and complete their reproductive phases. If any of the essential nutrients are not available, the plants will not grow well or may even die. On the other hand, some nutrients can cause problems for plants if their quantities in the soil are too high. Chemical properties includes soil pH, Electrical conductivity, Organic carbon, Organic matter, Available nitrogen, Phosphorous, Potassium in soil, secondary nutrients such as Calcium, Magnesium and Sulphur (Solanki *et al.,* 2012) [20].

Rajasthan is the largest Indian state covering an area of 342,239 square km or 10.4% of India's total geographical area and the seventh largest by population. It is known as "Land of Kings" state in Northern India. It is on India's northwestern side, where it comprises most of the wide and inhospitable Thar Desert (also known as the Great Indian Desert) and shares a border with the Pakistani provinces of Punjab to the northwest and Sindh to the west, along the Sutlej-Indus River valley. It is bordered by five other Indian states: Punjab to the north; Haryana and Uttar Pradesh to the northeast; Madhya Pradesh to the southeast; and Gujarat to the southwest. Its geographical location is 23.3^0 to 30.12^0 North latitude and 69.30^0 to 78.17^0 East longitudes, with the Tropic of Cancer passing through its southernmost tip.

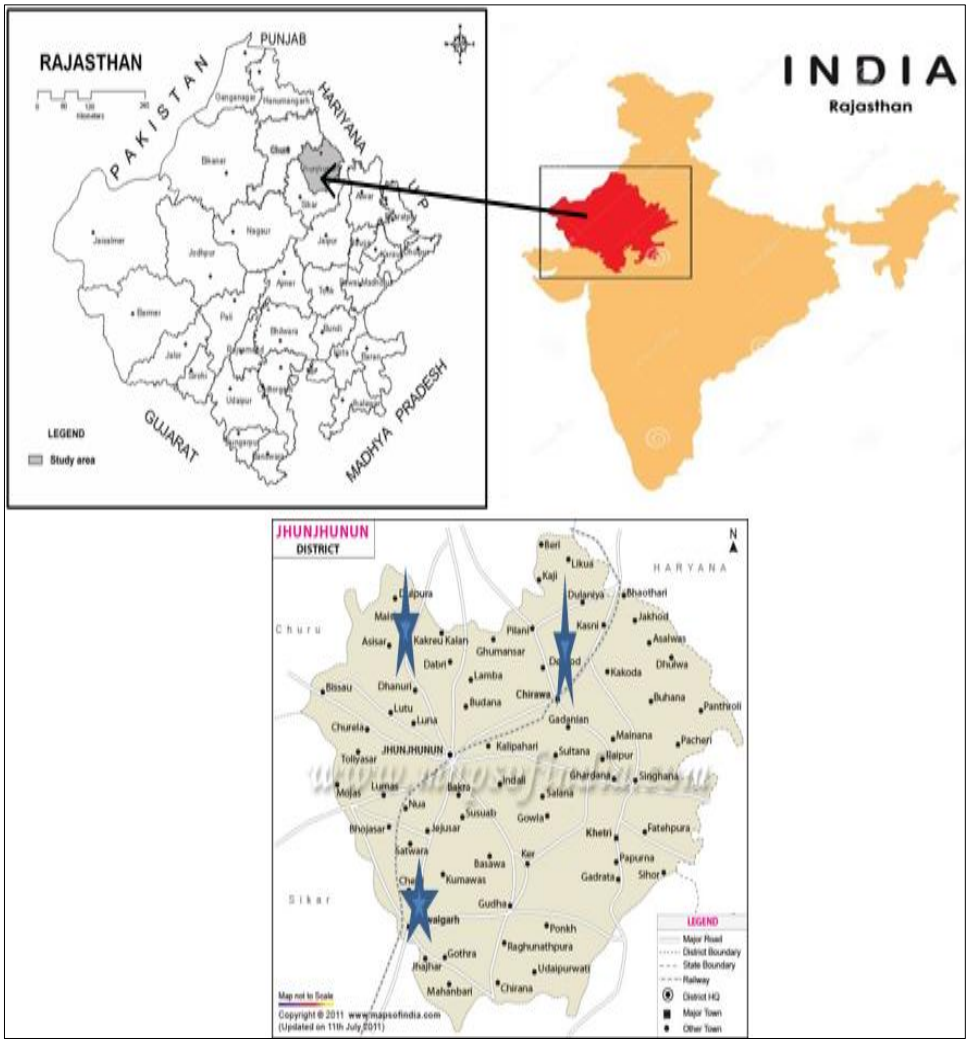
Study area

Jhunjhunu district is a district of the Indian state Rajasthan in northern India. The city of Jhunjhunu is the district headquarters. It lies between 75.02°N to 76.06°E longitude and 27.38°N to 28.31°E latitude with total geographical area is 5,928 km^2.

The district Jhunjhunu, Rajasthan comprising of 11 blocks out of which three blocks were selected for the soil sampling. Soil samples have been collected from Nawalgarh, Chirawa and Alsisar block at three different depths of 0- 15 cm, 15-30 cm and 30-45 cm respectively at the site (map, 1). Total twenty seven soil samples were collected at different depths of 0-15 cm, 15-30 cm and 30-45 cm respectively at the site. The collected soil samples were processed and analyzed for physico-chemical properties of soil by standard analytical methods.

Materials and Methods

Sieved soil samples were determined for physical properties of soil like its soil textural class by Bouyoucos hydrometer method (Bouyoucos, 1927) [4], soil color by using Munsell soil color chart (Munsell, 1954) [13], bulk density, particle density, percent pore space and water holding capacity was determined by 100 ml graduated measuring cylinder method (Muthuvel *et al.*, 1992) [14]. For determined the chemical properties of soil like its pH was determined by digital pH meter by making 1:2 soil-water suspension (Jackson, 1958) [10] whereas EC was measured by digital EC meter (Wilcox, 1950), Organic carbon was determined by wet-oxidation method (Walkley, 1947) [26], available nitrogen was determined by alkaline potassium permanganate method by 800 ml kjeldahl flask (Subbiah and Asija, 1956) [22], available potassium was determined by flame photometer using 1 N NH_4OAC (pH 7.0) (Toth and Prince, 1949) [24], available phosphorus was determined by colorimetric method by using spectrophotometer (Olsen *et al.*, 1954) [16], exchangeable calcium and magnesium were estimated by EDTA titration method (Cheng and Bray, 1951) [5], available sulphur was determined by turbidimetric method (Chesnin and Yien, 1950) [6].



Map 1: Locating sampling sites on map of Jhunjhunu district, Rajasthan

Results and Discussion

A. Physical properties

The results depicted that most of the soils of Jhunjhunu district in dry condition, reflected The soil color (dry condition) varied from dark brown to very dark brown, light brownish grey to yellowish brown and light yellowish brown to Dark greyish brown. The soil color (wet condition) varied from very dark greyish brown to Dark yellowish brown, yellowish brown to brownish yellow and dark brown color is mentioned in Table 1. Soil texture of soil samples was fall under sandy loam. The study revealed that Bulk Density ranges from 1.04 Mg m^{-3} to 1.29 Mg m^{-3} shown in figure 1. Same analysis was done by Bhuyan *et al.*, (2013) [3]. The particle density of soil varied from 2.22 to 2.66 Mg m^{-3}. The particle density increased due to increase in soil depth shown in figure 2. It does not usually very a lot in most soils Verma *et al.*, (2019) [25]. The study revealed that Porosity (%) ranges from 30.22% to 54.50% shown in figure 3. Pore space was found to decrease with increase in depth attributed to increase in compaction in the sub surface Verma *et al.*, (2019) [25]. The study revealed that Water Holding Capacity (%) ranges from 37.49% to 64.66% shown in figure 4.These variations were due to the silt, clay and organic carbon content and low Water Holding Capacity in sandy soils due to high sand and less silt content. The irregular trend of Water Holding Capacity with depth was due to the illuviation and eluviation of finer fraction in different horizons. Same analysis was reported by Sujatha *et al.*, (2016) [21].

Table 1: Soil Colour of villages from different blocks of Jhunjhunu district, Rajasthan

Blocks	Villages	Soil Colour					
		Dry condition			Wet condition		
		0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Nawalgarh (B_1)	Ajeetpura (V_1)	10YR 3/3 Dark brown	10YR 3/2 Very dark greyish brown	2.5YR 6/6 Brownish yellow	10YR 4/2 Dark greyish brown	10YR 3/2 Very dark greyish brown	10YR 4/4 Dark yellowish brown
	Jejusar (V_2)	7.5YR 3/2 Dark brown	7.5YR 4/4 Brown	2.5YR 6/6 Brownish yellow	7.5YR 5/4 Brown	7.5YR 4/2 Dark brown	10YR 4/2 Dark greyish brown
	Kari (V_3)	10YR 5/6 Yellowish brown	10YR 6/6 Brownish yellow	2.5YR 6/6 Brownish yellow	10YR 5/4 Yellowish brown	10YR 6/6 Brownish yellow	10YR 4/4 Dark yellowish brown
Chirawa (B_2)	Adooka (V_4)	10YR 4/3 Dark brown	10YR 5/2 Greyish brown	2.5YR 6/6 Brownish yellow	10YR 3/3 Dark brown	10YR 4/2 Dark greyish brown	10YR 4/4 Dark yellowish brown
	Agwana kalan (V_5)	10YR 3/3 Dark brown	10YR 3/3 Dark brown	10YR 3/3 Dark brown	10YR 3/3 Dark brown	10YR 3/3 Dark brown	10YR 3/3 Dark brown
	Agwana Khurd (V_6)	10YR 4/2 Dark greyish brown	10YR 4/2 Dark greyish brown	2.5YR 6/6 Brownish yellow	10YR 4/2 Dark greyish brown	10YR 4/2 Dark greyish brown	10YR 4/2 Dark greyish brown
Alsisar (B_3)	Batala (V_7)	7.5YR 5/4 Brown	7.5YR 4/4 Dark brown	2.5YR 6/6 Brownish yellow	7.5YR 4/4 Dark brown	7.5YR 4/4 Dark brown	7.5YR 4/4 Dark brown
	Birmi (V_8)	10YR 5/6 Yellowish brown	10YR 5/4 Yellowish brown	2.5YR 6/6 Brownish yellow	10YR 4/4 Dark yellowish brown	10YR 4/4 Dark yellowish brown	10YR 4/4 Dark yellowish brown
	Churela (V_9)	10YR 4/2 Dark greyish brown	10YR 4/2 Dark greyish brown	2.5YR 6/6 Brownish yellow	10YR 4/2 Dark greyish brown	10YR 4/3 Dark brown	10YR 4/4 Dark yellowish brown

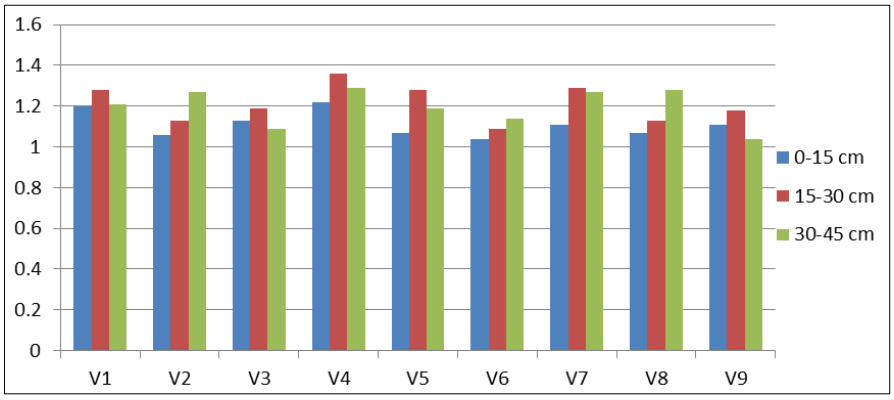


Fig 1: Bulk density of different villages of Jhunjhunu district

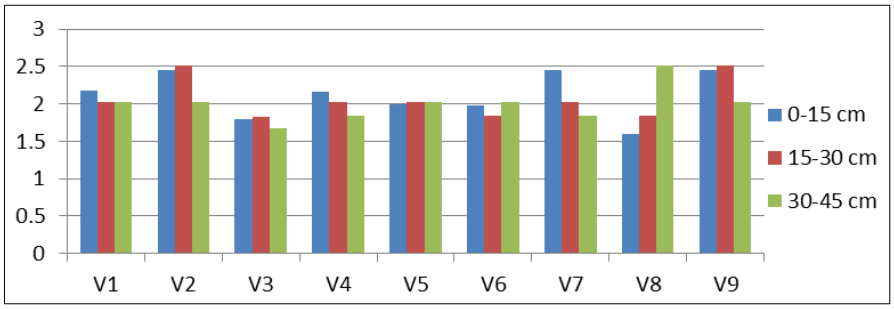


Fig 2: Particle density of different villages of Jhunjhunu district

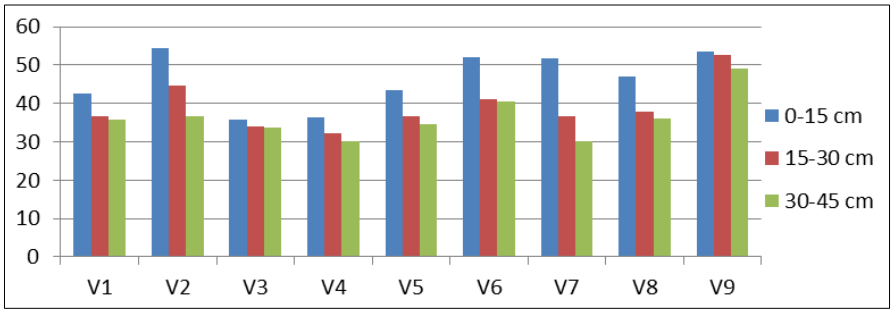


Fig 3: Porosity (%) of different villages of Jhunjhunu district

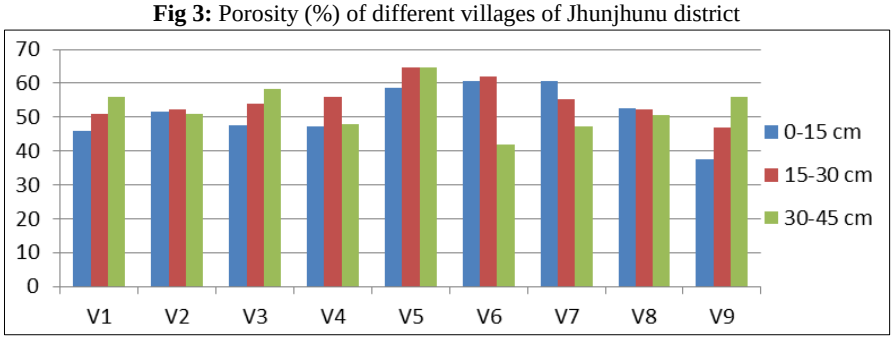


Fig 4: Water Holding Capacity (%) of different villages of Jhunjhunu district

B. Chemical properties

The soil pH ranges from 9.22 to 7.02 shown in figure 5. The reduction of soil pH value due to production of acids by bacterial action in anaerobic or nitrification processes in the soil. This range is a result of many factors, including a soils parent material and the amount of yearly rainfall an area receives. Similar results were reported by Kiran *et al*., (2012). The study revealed that EC ranges from 0.21 to 0.39 dS m^{-1} shown in figure 6. It indicates that the soils are non- saline and salinity effect is mostly negligible for the crops Tale *et al.*, (2015). The study revealed that Organic Carbon ranges from 0.31 to 0.80% shown in figure 7. The organic carbon increase with increasing depth due to the fact that surface soil contains undecomposed and partial decomposed organic matter while subsoil contains decomposed organic matter Singh *et al.*, (2012).

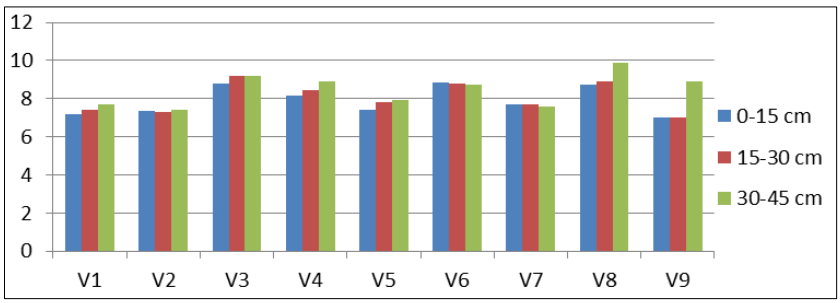


Fig 5: Soil pH of different villages of Jhunjhunu district

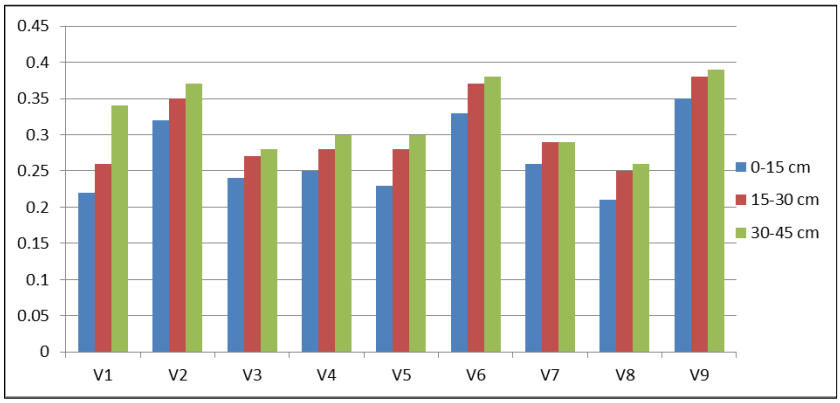


Fig 6: Electrical Conductivity of different villages of Jhunjhunu district

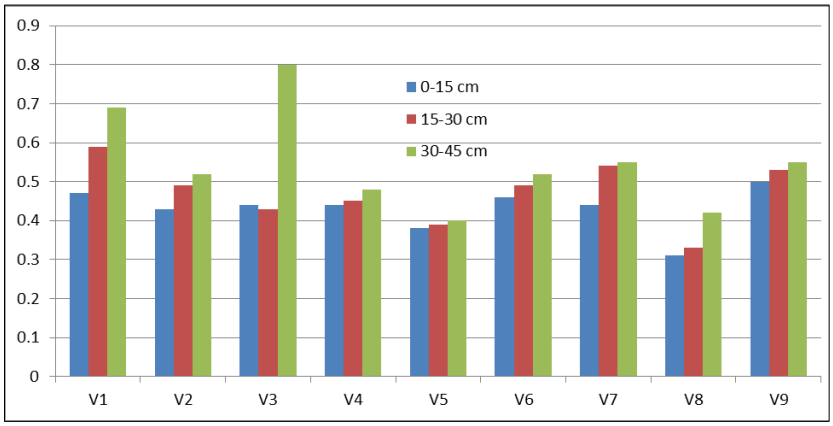


Fig 7: Soil OC (%) of different villages of Jhunjhunu district

The table 2 depicted the statistical accumulation on N-P-K (kg ha^{-1}) of villages and depths which was found to be significant at different fields. In village highest mean Nitrogen (kg ha^{-1}) was found 255.33 kg ha^{-1} at V_7 where lowest mean Nitrogen 161.66 kg ha^{-1} was found V_5. The available nitrogen decreased with the increased in soil depth shown in figure 8. Similar result analysis was noticed by Bhavya *et al.*, (2018) [2]. The study revealed that Available Phosphorus ranges from 15.20 to 26.35 kg ha^{-1}.The available phosphorous decreases with the increasing depth shown in figure 9. The higher level of available phosphorous in surface soil decreased with depth-wise. Similar results were found by Ghodke *et al.*, (2016) [8]. The study revealed that Available Potassium ranges from 109 to 245 kg ha^{-1} shown in figure 10. The highest available of K content was observed in the surface horizons and showed a less decreasing trend with depth. Similar result analysis was observed by Khanday *et al.*, (2018) [11].

Table 2: Available N-P-K at different depths (cm) of villages from different blocks of Jhunjhunu district, Rajasthan

Villages	N (kg ha^{-1})			P (kg ha^{-1})			K (kg ha^{-1})		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
AJEETPURA (V_1)	277	243	228	23.25	19.60	16.58	197	182	111
JEJUSAR (V_2)	180	172	164	22.72	19.20	17.34	179	161	146
KARI (V_3)	229	190	156	24.60	21.60	19.32	209	198	184
ADOOKA (V_4)	177	165	153	19.80	17.46	15.65	172	159	109
AGWANA KALAN (V_5)	180	155	150	19.45	17.03	15.20	150	137	130
AGWANA KHURD (V_6)	191	172	150	19.95	18.80	16.76	169	159	147
BATALA (V_7)	274	254	238	26.35	24.85	22.00	171	143	109
BIRMI (V_8)	230	195	170	25.40	22.10	19.40	245	170	146
CHURELA (V_9)	192	179	157	26.10	23.45	20.10	222	157	143

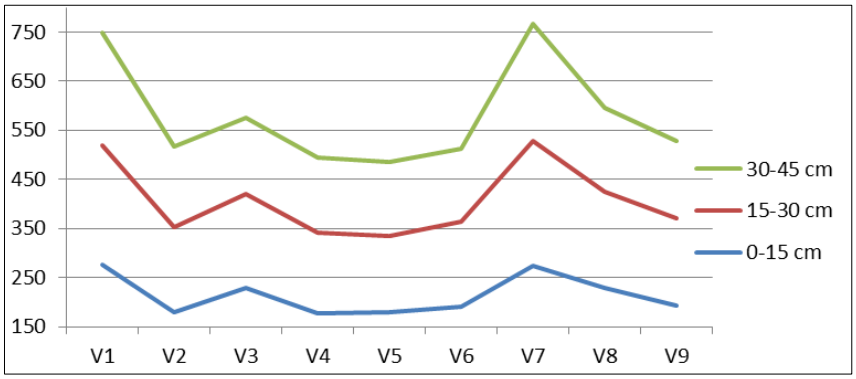


Fig 8: Available N (kg ha^{-1}) of different villages of Jhunjhunu district

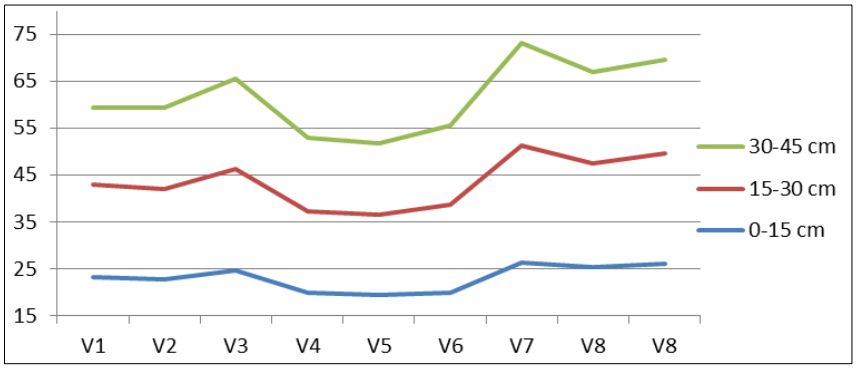


Fig 9: Available P (kg ha^{-1}) of different villages of Jhunjhunu district

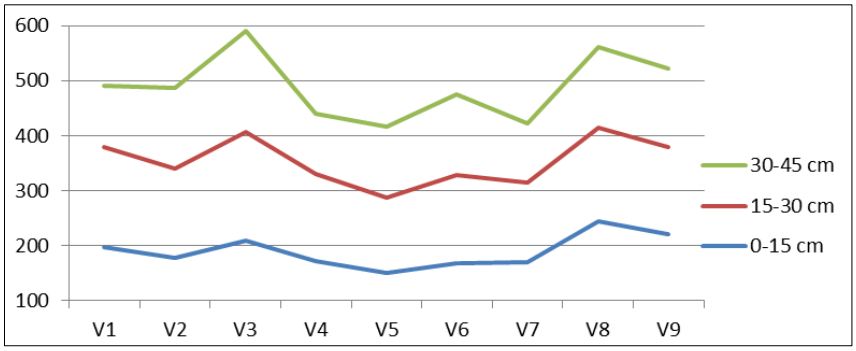


Fig 10: Available K (kg ha^{-1}) of different villages of Jhunjhunu district

The table 3 and fig. 11 depicted the statistical accumulation on Available Ca and Mg [cmol (p^+) kg^{-1}] and Sulphur of villages and depths which was found to be significant at various field plots. The study revealed that Available Calcium ranges from 2.45 to 5.70 cmol (p^+) kg^{-1}. Calcium contributes to soil fertility by helping maintain a flocculated clay and therefore with good aeration. Similar result analyses were reported by Ololade, I.A. (2010) [15]. The study revealed that Available Magnesium [cmol (p^+) kg^{-1}] ranges from 2.25 to 3.70 [cmol (p^+) kg^{-1}]. The similar analysis of result also found by Deshmukh, (2012) [7]. Available Sulphur (kg ha^{-1}) ranges from 21.00 to 29.00 kg ha^{-1}. The available sulphur increases with the increasing depth might be due to greater plant and microbial activities in surface soil Ghodke *et al.*, (2016) [8].

Table 3: Available Ca-Mg-S (kg ha^{-1}) at different depths (cm) of villages from different blocks of Jhunjhunu district, Rajasthan

Villages	Exchangeable Ca [cmol (p^+) kg^{-1}]			Exchangeable Mg [cmol (p^+) kg^{-1}]			Sulphur (kg ha^{-1})		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
ABUSAR(V_1)	3.80	3.65	3.13	2.80	2.60	2.45	21.00	22.00	22.01
AJEETPURA(V_2)	4.20	4.38	4.10	2.60	2.70	2.75	22.20	23.20	24.00
JEJUSAR KARI(V_3)	5.10	3.86	2.45	2.30	2.60	2.64	24.00	25.02	25.62
ADOOKA(V_4)	4.60	3.90	2.50	3.10	3.30	3.70	26.00	26.06	26.20
AGWANA KALAN(V_5)	5.40	4.85	4.12	3.40	3.45	3.50	25.04	25.70	25.02
AGWANA KHURD(V_6)	4.80	3.95	3.23	2.90	3.00	3.20	28.00	28.20	28.30
BATALA(V_7)	5.70	5.15	4.67	2.70	2.60	2.40	25.42	26.04	29.00
BIRMI(V_8)	4.50	3.98	3.05	2.50	2.40	2.25	23.00	23.03	23.43
CHURELA(V_9)	5.15	4.90	4.10	3.20	3.10	2.80	22.01	22.05	22.62

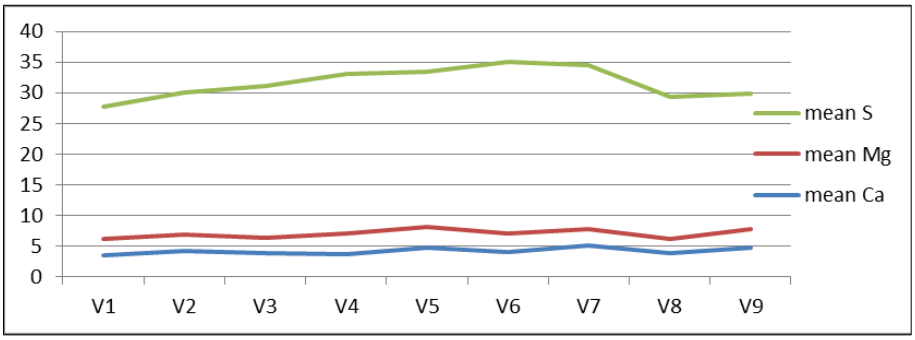


Fig 11: Mean Available Ca and Mg [cmol (p^+) kg^{-1}] and S (kg ha^{-1}) of different villages of Jhunjhunu district

Conclusion

It is concluded from the research work that the soils of Jhunjhunu district, Rajasthan are found to be significant with low to medium amount of macronutrients *viz.* Nitrogen, Phosphorous, Potassium and some sites showed a deficiency in secondary nutrients *i.e.* Magnesium and Sulphur except Calcium. The deficiency of the nutrients can be enhanced by adopting Integrated Nutrient Management. It shows that the soils are good for cultivation of various crops. Farmers are required to maintain Soil Health Card which helps them to adopt suitable management practices and provide proper nutrition to soil. These studies give information about the nature of the soil and present nutrient in soil based on this analysis of soil from Jhunjhunu district of Rajasthan.

Acknowledgement

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Conflict of Interest

As a corresponding Author, I Neha Kumari, confirm that none of others have any conflicts of interest associated with this publication.

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