Assessment of soil physical properties from different blocks of Jaipur district, Rajasthan, India

Abstract

The year 2021-2022, An analysis experiment was done for identification physical properties from the Rajasthan state at the Jaipur district area. For further study, twenty-seven soil samples were taken from farmer's fields in different three blocks of Jaipur district at depths 0-15 cm, 15-30 cm and 30-45 cm. The soil texture in the examined region was sandy loam. The difference of soil color also noticed in both the Air-dry condition and Moist condition and the color was light yellowish brown (10YR6/4) to brownish yellow (10YR5/8) and bulk density was from 1.24-1.34 Mg m^{-3}, The range of particle density was from 2.27-2.34 Mg m^{-3} and the pore space 37.77 to 43.65 %. The water retaining capacity % (WRC %) of soil ranged between 43.56 to 57.28 %. The specific gravity of soil ranged between 2.33 to 2.46. The manure and organic fertilizers are suitable for good soil health and maximum crop production at the farmer's field.

Keywords: physical Properties, Soil Texture, Soil color, Jaipur, etc.

Introduction

Soil is a dynamic natural body formed as a result of pedogenic processes by changing rock climates, including minerals and organic elements, with chemical, physical, mineralogical and biological properties, with varying depth of surface, and providing medium to plant growth. **(Thakre *et al.*,2012).** Soil is a finite and non-renewable resource that decides whether agricultural development programmes can be implemented in each country on the planet. Because of urbanization infrastructural expansion, industrial growth, and land degradation losses due to rapid erosion and secondary salinization, the arable land area has been shrinking **(Lal, 2013).**

Generally, the soil types of Rajasthan are sandy, saline, alkaline, and calcareous soils and were commonly called clay, loamy, and black lava soils. Groundwater level is very low because the annual rainfall is approximately 360 mm and the ground water level is very deep. Water is available at depths of 100 to 61 meters. India Rajasthan is divided into three agro-climate zones: Zone VI, Trans-Gangetic Plains region, Zone VIII, Central Plateau and Hills region, and Zone XIV, region of Western Dry. The soil of the Rajasthan region is classified as Aridisols, Alfisols, Entisol, Inceptisols and Vertisol according to the USDA Land Division program **(Chiroma *et al.*, 2014).** The capital of Rajasthan is the state of Jaipur and Jaipur is located between 26˚55′10″ N and 75˚47′16″ E. Jaipur has an average height of 1414 feet from sea level and Jaipur 11,152 km^2. The weather in Jaipur is desert. The average annual temperature is 25.2°C. The average rainfall in the Jaipur region is estimated at 650 mm. This type of climate and climate are applicable to kharif plants for example pearl millet, groundnut, cluster bean, sorghum, green gram and rabies plants wheat, mustard, barley, gram, pea, rapeseed, and taramira. As a result, current research was conducted to examine the visible soil structures from different blocks in the Jaipur region **(District Fact Book, 2019).**

The physical condition of a soil determines its support capacity **(Olivares, 2016),** ease of root penetration **(Olivares *et al.* 2020),** air circulation, water storage capacity **(Olivares *et al.* 2021),** drainage, nutrient retention, among other factors **(Olivares *et al.* 2022).** Among the main physical properties that influence crop development, the study by **Olivares *et al.* (2022)** points out that the Color of the soil is one of the characteristics that allows describing the different types of soils. Soil color does not have a direct effect on plant growth, but it indirectly affects soil temperature and moisture. The greater the amount of heat energy

found in the soil, the higher the temperature and evaporation will be. It has been proven that dark soils under the same environmental conditions and without plant cover, tend to dry out faster. On the other hand, moist soils are darker than those that are dry, in addition to absorbing more light that helps increase soil temperature and accelerate crop development.

On the other hand, **Olivares (2022)** establishes that the texture of the soil indicates the proportion of the fundamental particles of the soil: clay, silt and sand, which can be grouped into fine, medium and coarse, and also influences the quantity and availability of water. and nutrients, as well as in aeration, drainage and accessibility in the use of agricultural implements.

Also, soil moisture, according to **Olivares *et al.* (2020**) is referred to the amount of water available for the plant. Said content can vary according to the type and amount of clay and the percentage of OM found in the soil. The greater amount of clay and/or OM, the greater amount of retained water; that is why sandy soils tend to saturate more quickly than clay. It is important to know the irrigation management in the crop based on the type of soil and to avoid water stress that affects yield such as potato **(Olivares and Hernández, 2019),** corn **(Olivares *et al.* 2018a),** onion **(Olivares and Hernández, 2019). *et al.* 2018b**) and other crops **(Olivares *et al.* 2018c; Montenegro *et al.* 2021).**

The percentage of porosity is high in fine-textured soils with a higher proportion of micropores **(Olivares *et al.* 2019),** which favors greater moisture retention in relation to a sandy soil **(Olivares *et al.* 2015).** On the other hand, as bulk density increases, porosity decreases and directly influences soil aeration, leading to a decrease in root development in extreme cases. Pores with diameters of 0.2 to 0.3 mm limit root growth **(Olivares *et al.* 2011).**

Soil compaction refers to the reduction of soil porosity, increasing its bulk density **(Olivares *et al.* 2020).** Therefore, the compaction phenomenon limits the space for the storage or movement of air and water within the soil. In addition, it is one of the main causes of physical restriction for the radical growth of crops. The soils most prone to compaction are fine to medium textured soils compared to coarse textured soils. Similarly, soils with low organic matter content or with high moisture content are more susceptible to it **(Olivares, 2022).** The greatest compaction damage is found in agricultural fields in which intensive agriculture is practiced (high use of agricultural machinery); Compaction problems are normally found at different depths, depending on the type of implement used in soil preparation **(Olivares and López, 2019).**

Materials and Methods

State Rajasthan is situated at north side in India. The Rajasthan state 3,42,239 km^2 geographical area and it this is 10.4% of India's total geographical area. The Rajasthan state 27°23′28″ North latitude and 73º25′57″ East longitude on the map. It is a largest state of India. Rajasthan's district of Jaipur 26º55′10″ N latitude and 75º47′16″ E longitude is present on the Map. The all- study area was marked and divided in 3 blocks and in each block where selected 3 villages from the Jaipur district, they are Keshav Nagar (V_1), Morija (V_2), Nindola (V_3) in Chomu block (B_1), Goner (V_4), Shrikishanpura (V_5) and Durgapura (V_6), block in Sanganer (B_2), and Shivpuri (V_7), Manoharpur (V_8), Nwalpura (V_9), block in Shahpura (B_3). At collection of soil sampling site-, twenty-seven soil samples were collected at different depths of 0-15 cm, 15-30 cm and 30-45 cm.

Collection of Soil Sample: Soil samples were collected randomly from a site using Khurpi and Phawrah and Auger the depth of (a) 0-15cm, (b) 15-30cm, (c) 30-45 cm. Composite soil samples (by the process of conning and quartering method) was collected by Stratified soil sampling method **(Sahrawat *et al*., 2008, 2011; Chander *et al*., 2013)** and processed to analyzed the physical properties.

The detailed information is as follows:

- ❖ The grid soil samples at desired depth were taken as per the objective of the experiments.
- ❖ Record of latitude and longitude were maintained using GPS.
- ❖ The soil samples were collected with Khurpi, Phawrah and Auger.

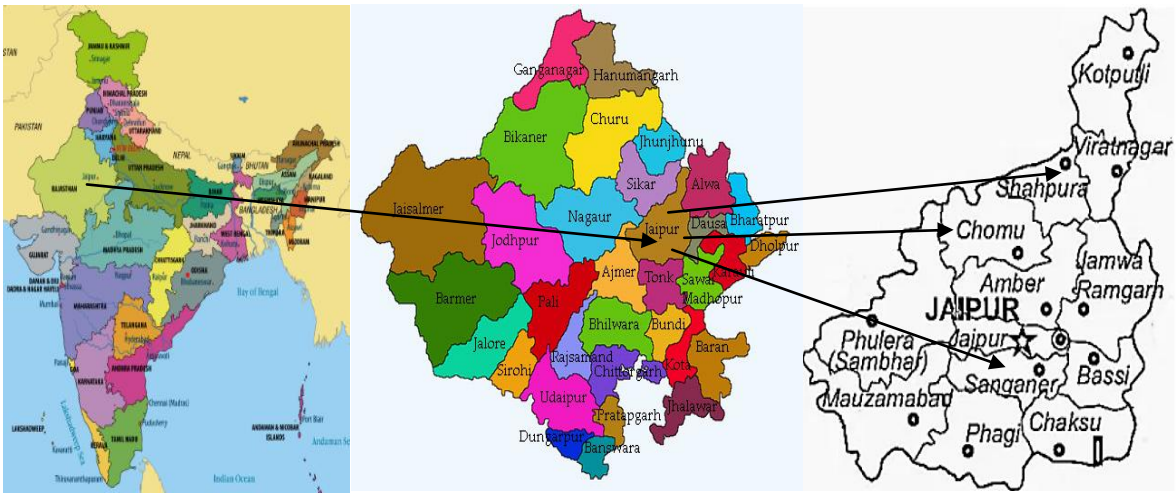

Fig 1: Soil sampling sites in 3 blocks from Jaipur district, Rajasthan, India

Process of Soil Sampling:

After collecting the soil samples, they were brought to the laboratory. These samples were dried under shade. After that the processing was done as follows:

- After the air drying under shade the unwanted materials like roots, stones, and others are should be discard.
- The clods in the sample would be broken by using the wooden mallet.
- After that the samples should be sieved with 2 mm sieve.

Analysis of physical properties Laboratory experiment which carried out in Department of soil science & Agricultural chemistry, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, (U.P.) India.

Methods of Analysis

S. No.	**Parameter**	**Method**
1.	Soil Texture	Bouyoucos Hydrometer
2.	Soil Colour	Munsell Colour chart
3.	Bulk Density (Mg m^{-3})	100 ml measuring Cylinder
4.	Particle Density (Mg m^{-3})	100 ml measuring Cylinder

5.	Pore Space (%)	100 ml measuring Cylinder
6.	Water Holding Capacity (%)	100 ml measuring Cylinder
7.	Specific gravity	R.D. Bottle Method

(**Source:** Soil Plant and Water Analysis, P.C. Jaiswal, 2011)

Results and Discussion

Physical properties

The results showed in soils from different villages of most of Jaipur district soils, Sandy Loam Texture was discovered at three depths (0-15 cm, 15-30 cm, and 30-45 cm) (Table-2). The percentages of sand, silt, and clay ranged from 60.11 to 72.60 percent, 13.35 to 24.59 percent, and 12.35 to 15.62 percent, respectively (Table-2). Same type result finding by **Mehta *et al.*, 2012, Meena *et al.*, 2017, and Choudhary *et al.*, 2021.** The soil color of soil also noticed in both the Air- dry condition and wet condition. The Soil color was Light Yellowish-Brown (10YR6/4) color to brownish yellow (10YR5/8) (Table-3). Similar results were reported by **Mehta *et al.*, 2012 and Choudhary *et al.*, 2021.** The results showed in soils from different villages The maximum bulk density was 1.35 Mg m^{-3} at 30-45 cm in village Morija (V_2), and the lowest bulk density was 1.22 Mg m^{-3} at 0-15 cm in village Nwalpura (V_9). with increasing soil depths, the bulk density increases (Table-1, Fig-2). **Meena *et al.*, 2017, Urmila *et al.*, 2018, and Choudhary *et al.*, 2021** all reported similar findings. At depth 30-45 cm in village Morija (V_2), the maximum particle density was 2.37 Mg m^{-3}, while at 0-15 cm in village Shivpuri, the minimum particle density was 2.24 Mg m^{-3} (V_7). Bulk density is lower than particle density (Table-1, Fig-2). **Meena *et al.*, 2017, Urmila *et al.*, 2018, and Choudhary *et al.*, 2021** all reported similar findings.

The largest percent pore space was reported at 0-15 cm in village Keshav Nagar (V_1), while the smallest percent pore space was measured at 30-45 cm in village Shivpuri (V_7). The % pore space decreases sharply as depth increases (Table-1, Fig-3). Similar findings were reported **by Meena *et al.*, 2017, Urmila *et al.*, 2018, and Choudhary *et al.*, 2021.** The maximum water holding capacity was found 60.12 % at 0-15cm in village Nwalpura (V_9) and minimum water holding capacity % was found 41.27 % at 30-45 cm in village Morija (V_2) (Table-1, Fig-3). These variations were due to clay, silt and organic carbon content and low Water holding capacity in sandy soils due to high sand and less clay content. Similar results were reported by **Urmila *et al.*, 2018, Pusty & Panda, 2019, and Choudhary *et al.*, 2021.** However in Village Shivpuri (V_7) had the highest specific gravity of 2.56 at 30-45 cm, while village Morija had the lowest specific gravity of 2.33 at 0-15 cm (V_2) (Table-1, Fig-2). Clay, silt, and organic carbon concentration all played a role, as did low Water holding capacity in sandy soils due to high sand and low clay content. **Sahu and David, 2014, and Choudhary *et al.*, 2021**

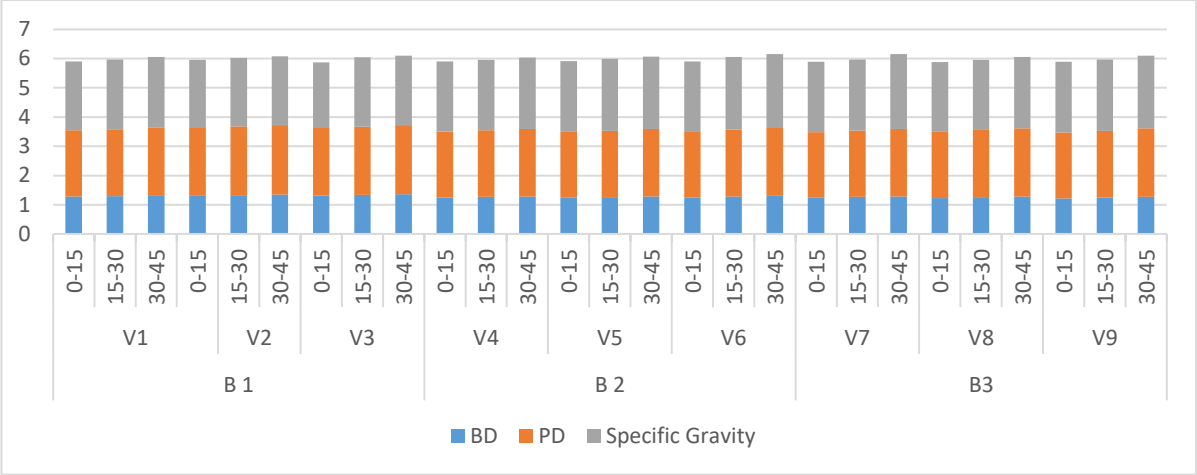

Fig 2: Status of bulk density, particle density and specific gravity of different blocks (villages) of Jaipur, Rajasthan

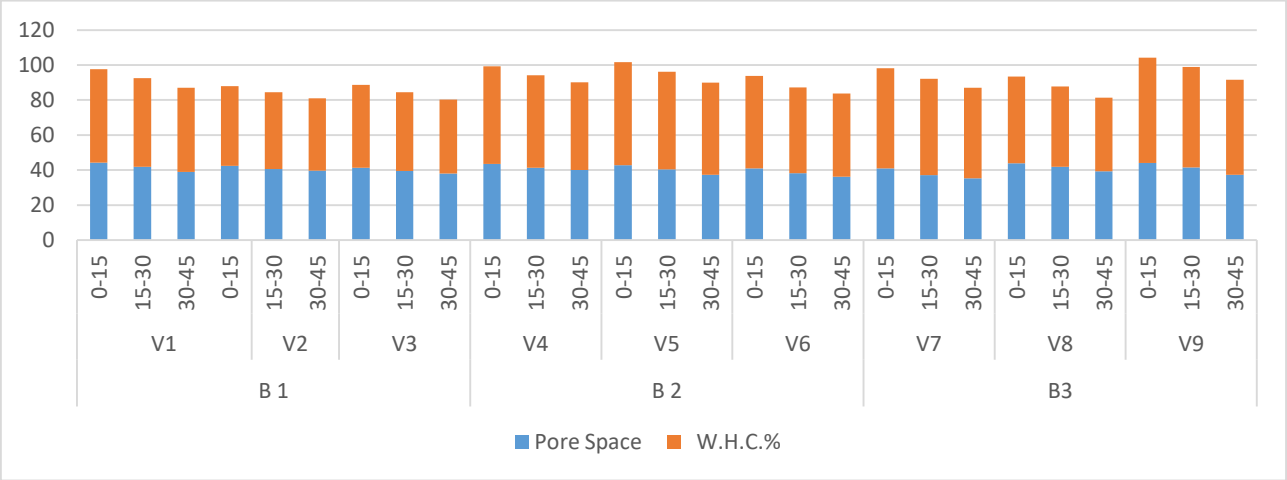

Fig 3: Status of pore space % and water holding capacity % of different blocks (villages) of Jaipur, Rajasthan

Table 2: Soil Texture in different villages of Jaipur at 0-15 cm, 15-30 cm and 30-45 cm depths**.**

Blocks	Village		0-15 cm	15-30 cm	30-45 cm
	V_1	% Sand	67.30%	70.82 %	72.60 %
		% Silt	19.33%	15.42%	13.35%
		% Clay	13.37%	13.76%	12.35%

		Texture Classes	Sandy loam	Sandy loam	Sandy loam
B_1	V_2	% Sand	70.41 %	71.00%	71.91%
		% Silt	16.56%	16.53%	15.09%
		% Clay	13.03%	12.47%	13.00%
		Texture Classes	Sandy loam	Sandy loam	Sandy loam
	V_3	% Sand	69.10%	70.99%	69.69%
		% Silt	16.74%	15.14%	15.22%
		% Clay	14.16%	13.87%	15.09%
		Texture Classes	Sandy loam	Sandy loam	Sandy loam
B_2	V_4	% Sand	66.71%	68.21%	69.15%
		% Silt	19.89%	18.56%	15.98%
		% Clay	13.50%	13.23%	14.87%
		Texture Classes	Sandy loam	Sandy loam	Sandy loam
	V_5	% Sand	67.10%	65.30%	62.50%
		% Silt	19.11%	20.52%	21.88%
		% Clay	13.79%	14.18%	15.62%
		Texture Classes	Sandy loam	Sandy loam	Sandy loam
	V_6	% Sand	66.85%	70.22%	69.59%
		% Silt	20.50%	16.73%	15.01%
		% Clay	12.65 %	13.05%	15.40%
		Texture Classes	Sandy loam	Sandy loam	Sandy loam
	V_7	% Sand	68.37%	66.40%	60.11%
		% Silt	17.93%	18.62%	24.59%
		% Clay	13.70%	14.98%	15.20%

B_3		Texture Classes	Sandy loam	Sandy loam	Sandy loam
	V_8	% Sand	68.33%	69.49%	70.05%
		% Silt	16.07%	15.57%	14.83%
		% Clay	13.60%	14.94%	15.12%
		Texture Classes	Sandy loam	Sandy loam	Sandy loam
	V_9	% Sand	66.90%	62.40%	63.70%
		% Silt	19.15%	22.50%	20.67%
		% Clay	13.95%	15.10%	15.63%
		Texture Classes	Sandy loam	Sandy loam	Sandy loam

Table 1: Bulk density (Mg m^{-3}), Particle density (Mg m^{-3}) and % Pore space, Water holding capacity %, Specific Gravity of soil in different villages of Jaipur at 0-15 cm, 15-30 cm and 30-45 cm depths.

Blocks	**Villages**	**Depth (cm)**	**BD (Mg m^{-3})**	**PD (Mg m^{-3})**	**Pore Space (%)**	**W.H.C.%**	**Specific Gravity**
B_1	**V_1**	**0-15**	1.29	2.26	44.17	53.41	2.35
		15-30	1.30	2.28	41.86	50.70	2.39
		30-45	1.33	2.32	38.92	48.16	2.40
	V_2	**0-15**	1.31	2.32	42.35	45.53	2.33
		15-30	1.33	2.35	40.55	43.89	2.34

		30-45	1.35	2.37	39.77	41.27	2.36
	V_3	**0-15**	1.32	2.31	41.42	47.24	2.24
		15-30	1.34	2.33	39.49	44.99	2.37
		30-45	1.36	2.36	38.13	42.13	2.38
B_2	**V_4**	**0-15**	1.25	2.26	43.49	55.86	2.39
		15-30	1.27	2.28	41.42	52.70	2.41
		30-45	1.29	2.30	40.04	50.05	2.44
	V_5	**0-15**	1.24	2.25	42.84	58.89	2.42
		15-30	1.26	2.27	40.36	55.75	2.46
		30-45	1.28	2.31	37.36	52.66	2.48
	V_6	**0-15**	1.25	2.27	40.92	52.89	2.38
		15-30	1.28	2.29	38.23	49.04	2.49
		30-45	1.31	2.32	36.29	47.39	2.52
B_3	**V_7**	**0-15**	1.24	2.24	41.00	57.24	2.41
		15-30	1.27	2.27	37.17	54.97	2.43
		30-45	1.29	2.30	35.23	51.78	2.56
	V_8	**0-15**	1.23	2.27	43.98	49.50	2.38
		15-30	1.26	2.30	41.92	45.90	2.40
		30-45	1.28	2.33	39.24	42.15	2.44
	V_9	**0-15**	1.22	2.25	44.09	60.12	2.42
		15-30	1.25	2.28	41.56	57.44	2.44
		30-45	1.27	2.34	37.23	54.30	2.49
F-test	**Due to depths**		S	S	S	S	S
	Due to site						
S.Ed.(±)	**Due to depths**		0.02	0.02	0.45	1.77	1.75
	Due to site		0.03	0.03	0.62	5.45	5.42
C.D.at 5%	**Duetodepths**		0.004	0.006	0.092	0.005	0.007
	Due to site		0.010	0.001	0.53	0.002	0.004

Table 3: shows the color of soil in different villages under dry and wet conditions in Jaipur at depths of 0-15 cm, 15-30 cm, and 30-45 cm.

Blocks	Village	Dry condition			Wet condition		
		0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
B_1	V_1	10YR6/4 Light Yellowish Brown	10YR6/6 Brownish yellow	10YR6/8 Brownish yellow	10YR4/3 Brown	10YR4/4 Dark yellowish brown	10YR4/4 Dark yellowish brown
	V_2	10YR7/6 Yellow	10YR7/6 Yellow	10YR6/8 Brownis yellow	10YR5/6 Yellowish brown	10YR5/6 Yellowish brown	10YR5/8 Yellowish Brown
	V_3	10YR6/4 LightYellowish Brown	10YR6/6 Brownish yellow	10YR6/6 Brownisyellow	10YR,5/8 YellowishBrown	10YR4/6 Dark yellowish brown	10YR4/6 Dark yellowish brown
B_2	V_4	10YR6/4 Light Yellowish Brown	10YR6/4 Light Yellowish Brown	10YR6/6 Brownis yellow	10YR4/4 Dark yellowish brown	10YR4/4 Dark yellowish brown	10YR4/6 Dark yellowish brown
	V_5	10YR6/6 Brownish yellow	10YR6/8 Brownish yellow	10YR6/8 Brownish yellow	10YR4/3 Brown	10YR4/4 Dark yellowish brown	10YR4/6 Dark yellowish brown
	V_6	10YR6/6 Brownish yellow	10YR6/8 Brownish yellow	10YR5/6 Yellowish Brown	10YR5/8 Yellowish Brown	10YR4/3 Brown	10YR4/4 Dark yellowish brown
B_3	V_7	10YR6/4 Light Yellowish Brown	10YR6/6 Brownish yellow	10YR6/8 Brownish yellow	10YR5/4 Yellowish Brown	10YR5/6 Yellowish Brown	10YR5/8 Yellowish Brown
	V_8	10YR6/6 Brownish yellow	10YR5/6 Yellowish Brown	10YR5/8 Yellowish brown	10YR5/6 Yellowish Brown	10YR4/4 Dark yellowish brown	10Y4/6 Dark yellowish brown
	V_9	10YR6/6 Brownish yellow	10YR6/8 Brownish yellow	10YR5/8 Yellowish brown	10YR4/3 Brown	10YR4/4 Dark Yellowish brown	10YR3/4 Dark yellowish brown

Conclusion: The soil of investigated area was sandy loam textured soil. The soil color was light Yellowish-Brown to brownish yellow which signifies a good organic matter. Improve of soil health by using organic manure and bio fertilizers and improve soil physical condition at study area, depth from upper to lower soil layers pore space % decrease because soil compacted, that is not suitable for good soil aeration. Growing Bajara, Mustard, Barley, Wheat, Tomato, Cole crops and Gram crops are suitable at present study area.

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