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TEMPORAL VARIABILITY AND DYNAMICS OF SOIL MOISTURE IN SESAME (SESAMUM INDICUM L.) FIELDS USING THE GRAVIMETRIC METHOD DURING THE SUMMER SEASON

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ABSTRACT

Soil moisture is a critical parameter influencing crop growth, irrigation scheduling, and yield. Understanding its temporal variation is essential for effective water management in agriculture. This study investigates the temporal variability of soil moisture for the sesame crop using satellite overpass data during the growing season from 01 March 2020 to 10 May 2020 at 10-day intervals. Soil moisture observations were collected from four representative locations within the study area, and average soil moisture was computed for each date. Results showed that soil moisture varied between 9.72% and 22.11%, reflecting crop growth stages, irrigation practices, and evapotranspiration demand. The findings demonstrate the usefulness of satellite-based temporal analysis for monitoring soil moisture dynamics and supporting precision irrigation management in sesame cultivation.

Keywords: Soil moisture, Sesame crop, Temporal variability, Remote sensing, Satellite data

1 Introduction:

Efficient water management is crucial for sustainable agricultural production, especially for oilseed crops like sesame (Sesamum indicum L.). Soil moisture plays a vital role in crop growth, nutrient uptake, and final yield. Maintaining optimum soil moisture is particularly important for sesame, as water stress at critical growth stages can significantly reduce productivity. Understanding the temporal variability of soil moisture helps in assessing crop water requirements, optimizing irrigation schedules, and improving water-use efficiency. Conventional gravimetric methods accurately measure soil moisture but are labor-intensive, time-consuming, and limited to specific points. Integrating satellite overpass data with ground

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measurements offers a practical, cost-effective way to monitor soil moisture continuously over large areas, capturing spatial variability across soils and crop stages.

In this study, soil moisture was measured at four locations using the gravimetric method and recorded at multiple intervals from March 1 to May 10, 2020, synchronized with satellite overpasses. The data captured temporal variations in soil moisture influenced by crop growth, evapotranspiration, rainfall, and irrigation. Analyzing these trends helps understand field water balance, crop response to environmental factors such as temperature, humidity, wind, and soil type, and supports efficient irrigation scheduling to reduce water wastage and improve sesame crop yield.

The present study emphasizes the importance of integrating field-based gravimetric measurements with satellite data to assess the temporal variability of soil moisture in sesame crops, which can serve as a valuable tool for precision agriculture and sustainable water management practices.

1.2 Objectives of the study:

1) To monitor temporal changes in soil moisture of the sesame crop using the gravimetric method.
2) To study soil moisture variation across different satellite overpass dates.
3) To assess soil moisture depletion during the crop maturity and harvesting stage.

2 Materials and Methods

2.1 Study area

The experiment was conducted at the Instructional Farm, College of Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh (Fig. 1.). The latitude and longitude of the study area are 21°28’59.19” to N 21°29’02.54” N (North latitude) and 70°26’09.83” E to 70°26’10.45” E (East longitude).

2.2 Data Collection and Software Used

Remote sensing and GIS analyses were carried out using QGIS 3.16. Sentinel-2A satellite data and ground-based digital camera images were used to derive vegetation indices, generate spatial maps, and perform image processing, raster calculations, spatial analysis, and visualization for crop monitoring.

2.3 Measurement of Soil Moisture Using the Gravimetric Method

The soil moisture content may be expressed on a weight basis, which is the ratio of the weight of water present to the dry weight of the soil sample. To determine the soil moisture content of a particular soil sample, the mass of water was determined by drying the soil in hot air oven at 105°C for 24 h to a constant weight and measuring the mass of the soil sample before and after drying. The water mass (or weight) is the difference between the weights of the wet and oven-dry samples.

The moisture content on a dry weight basis was calculated using the following formula (Shukla *et al*., 2014):

$$M_d = \frac{(W1) - (W2)}{(W2)}$$

Where,

W1 = Weight of wet soil

W2 = Weight of dry soil

M_d = Moisture content in dry weight basis

2.4 Temporal Sampling and Analysis

Soil moisture was recorded at 10-day intervals from 01 March 2020 to 10 May 2020. Four representative locations in the field were selected, and the average soil moisture was computed for each date. Satellite overpass dates were synchronized with field measurements to validate temporal trends.

3. RESULTS AND DISCUSSION

3.1 TEMPORAL VARIABILITY OF SOIL MOISTURE FOR SESAME CROP

A total of four locations were selected from the study area, from which four points were taken to find the soil moisture for the land. The temporal variability of soil moisture for the period of March 01, 2020, to May 10, 2020, at an interval of 10 days is given in Table 1. The trends of soil moisture for the sesame crop were shown in Fig. 2.

Table 1: Soil moisture content as per date of satellite overpasses.

Sr. No.	Date of satellite Overpasses	1	2	3	4	Average Soil moisture (%)
1	01-03-2020	12.04	11.85	10.07	13.94	11.97

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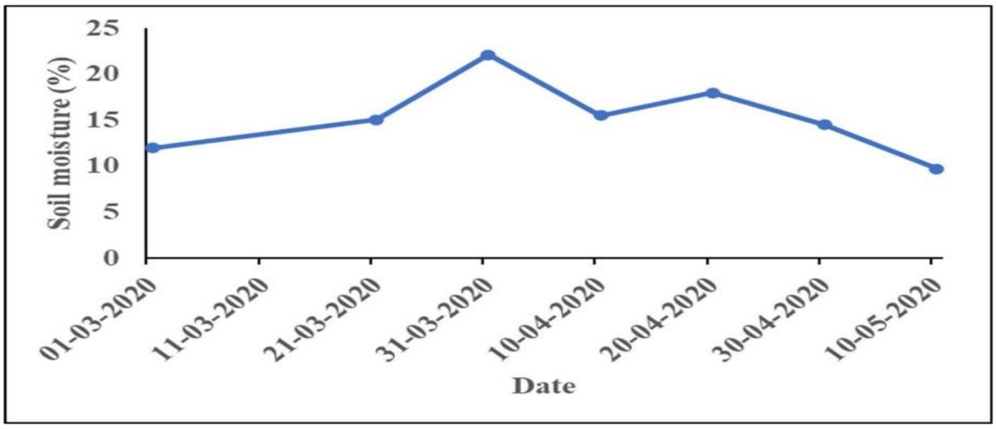
2	21-03-2020	15.16	14.98	13.94	16.2	15.07
3	31-03-2020	24.27	22.33	20.45	21.42	22.11
4	10-04-2020	13.45	16.5	14.6	17.6	15.53
5	20-04-2020	19.7	18.54	17.3	16.3	17.96
6	30-04-2020	17.23	12.69	12.7	15.4	14.50
7	10-05-2020	8.7	9.4	11	9.8	9.72

Fig. 2 Temporal Variability of soil moisture for Sesame crop



The Fig. 2 shows the soil moisture variability for land use, where y indicates soil moisture percentage and the x-axis indicates the date of satellite overpasses. The value of soil moisture was found to vary between 9.72 and 22.11%, which indicates the variability of soil moisture. The highest value of soil moisture was found to be 22.11%, whereas the lowest value of soil moisture was 9.72%. After harvesting of the sesame crop, soil moisture showed a decrease because 10-15 days before application of water to the crop was stopped. The graph justifies the amount of water used by the crop or evapotranspiration at any time, which depends on the growth stage of the crop, air and soil temperature, wind speed, relative humidity, plant physiology, and available soil moisture.

3.2 Factors Influencing Soil Moisture Variability

The temporal changes in soil moisture were influenced by several factors:

1) **Evapotranspiration:** As the crop grew, water loss from soil increased, particularly during warm days.

2) **Irrigation practices:** Water application was stopped 10–15 days before harvest, leading to decreased soil moisture.
3) **Environmental conditions:** Temperature, wind speed, and relative humidity affected soil water depletion.
4) **Crop growth stage:** Soil moisture peaked during vegetative growth and declined during reproductive and maturity stages.

These findings align with previous studies reporting similar temporal trends in oilseed crops, where soil moisture varies according to crop growth, evapotranspiration, and irrigation (Shukla et al., 2014).

3.3 Implications for Water Management

The results highlight the importance of monitoring temporal soil moisture for efficient water management. Understanding moisture trends can help in:

1) Optimizing irrigation schedules to prevent water stress.
2) Reducing water wastage by applying water according to crop demand.
3) Supporting precision agriculture practices for better yield and resource management.

The integration of gravimetric field measurements with satellite overpass data provides a practical, cost-effective method to monitor soil moisture variability across large fields, enabling farmers to make informed irrigation decisions and improve water-use efficiency.

4. Conclusion

The study highlights the temporal variability of soil moisture in sesame crops, ranging between 9.72% and 22.11%. Integrating gravimetric measurements with satellite data provides a robust and cost-effective approach for monitoring soil moisture dynamics. This methodology supports precision irrigation, improves water-use efficiency, and can be applied to other crops for sustainable agriculture.

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