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Measurement of leaf area index (LAI) of wheat crop using plant canopy analyzer

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ABSTRACT

Wheat (*Triticum aestivum* L.) is a major cereal crop, and monitoring its canopy dynamics is important for effective crop management. The Leaf Area Index (LAI) serves as a key indicator of canopy structure and growth status. A field study was conducted during the 2024–25 Rabi season at the Wheat Research Centre, Junagadh Agricultural University, Gujarat, using the wheat variety GJW 463. LAI was measured at ten fixed sites on four dates using the LAI-2200 Plant Canopy Analyzer, which records above- and below-canopy light transmission to provide non-destructive estimates of leaf area.

Results showed that LAI peaked in late January (mean 3.88) and declined gradually to 2.51 by late February, reflecting the transition from vegetative growth to grain development and canopy aging. The LAI-2200 proved reliable in capturing these changes, supporting its value as a practical tool for monitoring wheat growth and aiding crop management decisions.

Keywords: Leaf Area Index (LAI), Canopy, Canopy Dynamics, Plant Canopy Analyzer

Introduction

Wheat (*Triticum aestivum* L.) is one of the most ancient and widely cultivated cereal crops in the world, and it continues to remain a cornerstone of global agriculture and food security (Cuong *et al.*, 2020; Sharma *et al.*, 2015) [1, 2]. Belonging to the Poaceae family, wheat is a self-pollinated, long-day plant that thrives particularly well under arid and semi-arid conditions (Belderok, 2000) [3]. Its versatility and adaptability across diverse agro-ecological zones have allowed it to become one of the most important food crops, supplying a significant portion of daily energy and protein requirements to millions of people worldwide. As a staple food, wheat not only contributes to caloric intake but also plays a critical role in meeting the nutritional demands of some of the most vulnerable populations around the globe.

The Leaf Area Index (LAI), which measures the relationship between leaf surface and ground area, is a crucial metric in ecology and agriculture. Due to its dimensionless nature, LAI is defined as the one-sided leaf area per unit of ground surface (Addink *et al.*, 2007) [4]. This metric is closely related to photosynthetic efficiency, which in turn controls plant development and yield production. LAI is a crucial biophysical characteristic that reflects crop health, according to Bryson *et al.* (1997) [5]. It is highly impacted by planting density, growth stage, plant height, and canopy architecture.

In order to control light interception, canopy temperature, and transpiration, canopy characteristics including as height, density, and leaf orientation are essential. Usually, a dense canopy with a larger Leaf Area Index (LAI) improves radiation capture and raises biomass and production. For this reason, LAI is commonly used in combination with canopy parameters to assess crop vigor and production potential. Plant stress, water status, nutrient deficiencies, and evapotranspiration, along with Leaf Area Index (LAI) dynamics, can all be effectively monitored using remote sensing technologies, particularly through vegetation indices such as the Normalized Difference Vegetation Index (NDVI) (Parmar *et al.*, 2016; Parmar *et al.*, 2019; Parmar *et al.*, 2022) [6, 7, 8].

Leaf Area Index (LAI) can be estimated using both direct and indirect methods. Direct approaches generally involve destructive sampling, such as harvesting vegetation within a defined area to measure leaf surface area (Breda, 2003) [9]. Alternative direct techniques include the development of allometric models, for instance, estimating leaf area from litter trap data in relation to canopy spread (Vyas *et al.*, 2010) [10] or correlating it with plant traits such as diameter at breast height or crown base (Makela *et al.*, 1995) [11]. In contrast, indirect methods rely on quantifying radiation transmission through the canopy (Anderson, 1971) [12]. Commonly employed instruments for such measurements include the AccuPAR LP-80 (Tripathi *et al.*, 2014) [13] and the LAI-2000 Plant Canopy Analyzer (Behera *et al.*, 2015) [14].

Keeping this in mind, the present study was planned with the following goal.

To measure the Leaf Area Index (LAI) for monitoring the growth dynamics of wheat.

2. Materials and Methods location

The experiment was carried out at the Wheat Research Centre of Junagadh Agricultural University (JAU), Junagadh, Gujarat, during the Rabi season of 2024–25. The site has semi-arid climatic conditions with mild winters, which are favourable for wheat cultivation. The soil of the experimental field is medium black, with good moisture-holding capacity that supports crop growth under irrigated conditions.

The wheat variety selected for the study was GJW 463, which is commonly cultivated in this region due to its adaptability and stable yield. The crop was grown following recommended agronomic practices to maintain uniform growth. For recording observations, 10 fixed locations were identified across the experimental plot. These locations were chosen in such a way that they represented the overall condition of the crop stand.

2. Data collected

2.2.1 Instrument used

The Leaf Area Index (LAI) was measured using the LAI-2200 Plant Canopy Analyzer. This instrument works on the principle of light interception and allows non-destructive measurement of canopy charac-

teristics. It records how much light passes through and is absorbed by the canopy, and then calculates the LAI.

2.2.2 Observation schedule

Measurements were carried out on four different days, which represented important stages of wheat crop growth. To ensure proper field representation, 10 observation sites were marked across the experimental plot. These were chosen to capture the variation in the crop stand.

2.2.3 Procedure followed

At each observation site, one LAI value was calculated from 12 consecutive readings taken with the LAI-2200. In this process, “A” denoted readings taken above the canopy and “B” denoted readings taken below the canopy.

To maintain uniformity, the readings were always taken in the same fixed order:

A BBB A BBB A BBB

This sequence was designed to balance both above- and below-canopy measurements. Once the full set of 12 readings was completed, the instrument processed the data and provided the final LAI value for that observation site.



Figure 1. In-field measurement of Leaf Area Index (LAI) using the LAI-2200 Canopy Analyzer, above (A) and below (B) the canopy

2.2.4 Data processing

The same procedure was repeated across all 10 sites on each observation day. The values obtained were averaged to represent the final LAI of the crop for that growth stage. This approach reduced random errors and provided a reliable estimate of the canopy development of wheat variety GJW 463.

2. Results and discussion measurement of leaf area index using LAI 2200 canopy analyser

The Leaf Area Index (LAI) values recorded with the LAI-2200 Plant Canopy Analyzer showed a clear decline during the observation period. On January 29, 2025, the maximum, minimum, and average LAI

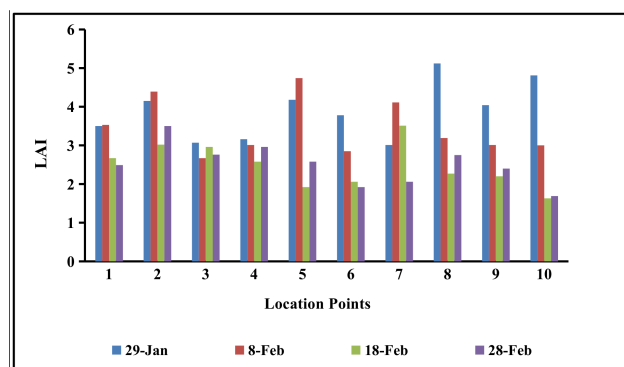
values were 5.12, 3.01, and 3.88, respectively, indicating a dense and actively expanding canopy at the late vegetative stage. By February 8, the values had decreased slightly to 4.74, 2.67, and 3.45, reflecting the beginning of the transition from vegetative to reproductive growth. A more pronounced decline was observed on February 18, when the maximum, minimum, and average LAI values dropped to 3.51, 1.63, and 2.48, suggesting rapid leaf senescence and canopy thinning. By February 28, the values were 3.50, 1.69, and 2.51, confirming that the canopy had stabilized at a lower level as the crop moved closer to maturity.

Table 1. LAI Plant Canopy Analyzer values of the Wheat crop				
Location Points	Date of data collection			
	29/01/2025	8/02/2025	18/02/2025	28/02/2025
1	3.5	3.53	2.67	2.49
2	4.15	4.39	3.02	3.5
3	3.07	2.67	2.96	2.76

(continued on next page)

Table 1. LAI Plant Canopy Analyzer values of the Wheat crop

4	3.16	3.01	2.58	2.96
5	4.18	4.74	1.92	2.58
6	3.78	2.85	2.06	1.92
7	3.01	4.11	3.51	2.06
8	5.12	3.19	2.27	2.75
9	4.04	3.01	2.2	2.4
10	4.81	3	1.63	1.69
Average	3.882	3.45	2.482	2.511

**Figure 2.** Variability of LAI 2200 Canopy Analyzer of the wheat crop

Overall, the findings show that LAI gradually decreased between late January and late February. January's greater LAI values were associated with maximum light interception and peak canopy development, whereas the subsequent fall was a reflection of the wheat crop's normal transition towards senescence and the transfer of assimilates to reproductive structures. Similar trends have been noted in wheat, where LAI slowly decreases during flowering and grain filling after peaking close to the booting or heading stage. These findings demonstrate how well the LAI-2200 Plant Canopy Analyzer recorded changes in canopy structure over time and produced accurate data for tracking crop growth in the field. Sandmann *et al.* (2013) [15] evaluated the LI-COR LAI-2200 for non-destructive estimation of Leaf Area Index (LAI) in Kohlrabi. Among the various configurations tested, the setup that best aligned with destructive sampling results demonstrated the analyzer's accuracy and reliability for field-based LAI assessment. This finding supports the use of the LAI-2200 as a dependable tool for monitoring canopy development in crops under field conditions.

3. Conclusion

The study showed that the LAI-2200 Plant Canopy Analyzer is a useful instrument for tracking the growth dynamics and canopy development of wheat in the field. A distinct temporal pattern was seen in the LAI values, which peaked in late January during the peak vegetative stage and then gradually declined through February as the crop matured. These patterns show the assimilate redistribution to growing grains and the organic shift from active leaf growth to senescence. The findings demonstrate how beneficial LAI measures are for determining canopy status, comprehending growth stages, and assisting with crop management choices in wheat farming.

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