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State–Wise Analysis of Area, Production and Productivity of Pomegranate in India (2023–24): A Regional Comparative Study

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A B S T R A C T

This study examines India's regional variations in pomegranate cultivation using 2023–24 state-wise area, production and productivity data. Western–Central India, especially Maharashtra and Gujarat, continues to dominate national production, while Andhra Pradesh leads in productivity. Northern, Eastern and North-Eastern regions perform substantially below the national average due to climatic constraints and limited adoption of modern technologies. These findings are consistent with previous research highlighting the role of drip irrigation, regulated deficit irrigation, micronutrient sprays and post-harvest management in improving yield. The study identifies major regional gaps and emphasizes the need for targeted interventions to enhance India's pomegranate sector

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INTRODUCTION

Pomegranate (Punica granatum L.) is one of India's fastest-growing commercial fruit crops, valued for its export potential, drought tolerance and high nutritional quality. India is currently among the world's leading producers, supported by expanding cultivation in arid and semi-arid regions. Scientific research has demonstrated that pomegranate productivity is highly responsive to improved water and nutrient management. Intrigliolo et al. (2013) found that regulated deficit irrigation significantly enhances fruit quality while optimizing water use. Similarly, Rodríguez et al. (2012) reported that water relations in pomegranate leaves are highly sensitive to irrigation strategies, influencing both vegetative growth and yield.

Micronutrient management has also been shown to play a critical role. Davarpanah et al. (2016) observed that foliar applications of zinc and boron improved fruit set, yield and quality. Maity et al. (2021) further confirmed micronutrient responsiveness across cultivars commonly grown in India. Kaolin spray technologies, widely studied for heat and sunburn management, have been found effective in enhancing fruit quality in hot regions like Maharashtra and Gujarat (Melgarejo et al., 2004; Al-Saif et al., 2022).

Genetic variability strongly influences performance. Khadivi (2021) identified several high-potential pomegranate genotypes with superior morphological and pomological traits. In India, variability in yield performance is also influenced by fertigation strategies, as shown in fertigation trials conducted by Thakur (2023), where improved nutrient delivery significantly increased productivity.

Despite extensive research, regional disparities persist due to climatic differences, resource limitations and varying adoption levels of scientific practices. This study evaluates state-wise regional performance using 2023–24 data and interprets patterns in light of current scientific evidence.

LITERATURE REVIEW

The scientific literature offers extensive insights into agronomic factors influencing pomegranate productivity. Water management has been among the most widely researched themes. Intrigliolo et al. (2013) demonstrated that sustained and regulated deficit irrigation (RDI) enhances fruit quality without significantly reducing yield, making it suitable for semi-arid regions. This is supported by Rodríguez et al. (2012), who reported that pomegranate leaf water relations change dynamically under various irrigation conditions, influencing physiological performance.

Kaolin application forms another major research theme. Melgarejo et al. (2004) found that kaolin sprays reduce sunburn damage and improve fruit appearance, while Al-Saif et al. (2022) showed that kaolin combined with calcium and potassium foliar sprays enhances fruit quality and yield. These findings are highly relevant for hot regions like Maharashtra and Gujarat where sunburn is a major commercial constraint.

Research on nutrient management indicates that micronutrients significantly influence fruit quality and yield. Davarpanah et al. (2016) documented improvements in fruit set and quality following zinc and boron

nano-fertilizer applications. Maity et al. (2021) reported similar improvements across three commonly cultivated Indian cultivars. Fertigation-based studies have also shown positive outcomes; Thakur (2023) highlighted that controlled nitrogen fertigation increases growth and productivity in cv. Kandhari Kabuli.

Genotypic variability also contributes significantly to differential performance. Khadivi (2021) identified superior genotypes with high pomological value, suggesting that cultivar selection plays a critical role in determining productivity. Review studies, such as Saroj and Kumar (2019), summarize modern production technologies, post-harvest management, and export-oriented practices, emphasizing the need for technological adoption.

Overall, the literature establishes that irrigation precision, kaolin sprays, nutrient management and improved cultivars are key drivers of high productivity.

Objectives

1. To evaluate state-wise area, production and productivity of pomegranate in India for 2023–24.
2. To compare the performance of major regions of India.
3. To interpret the regional variations using insights from scientific research.
4. To identify regions with potential for improvement.
5. To propose interventions for enhancing national productivity.

METHODOLOGY

Research Design

The study followed a descriptive and analytical research design aimed at evaluating the regional disparities in pomegranate cultivation across India. The research combined primary-style structured data compilation with secondary literature integration, enabling both quantitative and qualitative interpretation of national production patterns.

Data Source and Compilation Procedure

The dataset used in this research was collected, organized and verified by the researcher for the agricultural year 2023–24. The data included:

- Area under pomegranate cultivation ('000 hectares)
- Total production ('000 metric tonnes)
- Productivity (MT/ha)

The information was systematically compiled region-wise for:

- Western & Central India
- Southern India
- Northern India
- Hindi Belt States
- Eastern India
- North-East India

The researcher obtained the raw state-wise statistics from official agricultural records, horticulture departments and validated regional datasets, then formatted and categorized them into uniform tables for analysis.

Data Organization and Classification

The collected data was cleaned, cross-verified and categorized into six major agro-regional clusters based on:

- Climatic zones
- Traditional cultivation patterns
- Administrative classifications

Each region was assigned aggregated values for area, production and productivity, ensuring consistency for comparative evaluation.

Analytical Framework

The analysis was carried out in four phases:

1. Phase 1: Quantitative Tabulation
   All state-level numbers were entered into structured tables for easy comparison. Regional totals were computed by summing individual state contributions.
2. Phase 2: Productivity Comparison
   Productivity (MT/ha) was assessed using the formula:
   Productivity=Total Production (’000 MT)Area (’000 ha)
   Productivity = \frac{\text{Total Production (’000 MT)}}{\text{Area (’000 ha)}}
   Productivity=Area (’000 ha)Total Production (’000 MT)
   This enabled cross-regional evaluation of efficiency, independent of cultivated area.
3. Phase 3: Pattern Identification
   Using the quantitative results, performance patterns were identified:
   - High-performing regions
   - Low-performing regions
   - Outliers (e.g., Andhra Pradesh with exceptionally high productivity)

   The numerical patterns were then compared with documented agronomic findings from peer-reviewed research (e.g., irrigation efficiency, micronutrient responsiveness and climatic factors).
4. Phase 4: Integration With Scientific Literature
5. Empirical findings from the data were interpreted alongside relevant published studies such as:
   - Regulated deficit irrigation (Intrigliolo et al., 2013)
   - Micronutrient foliar sprays (Davarpanah et al., 2016; Maity et al., 2021)
   - Kaolin sunburn mitigation (Melgarejo et al., 2004; Al-Saif et al., 2022)
   - Genotype performance variability (Khadivi, 2021)

   This integration allowed the researcher to contextualize numerical results with scientifically validated agronomic principles.

Tools and Techniques Used

The following analytical techniques were applied:

- Manual data verification to eliminate inconsistencies
- Excel-based computation for totals and productivity
- Comparative regional analysis
- Interpretive synthesis combining statistical outcomes with agronomic literature

No simulation tools, GIS models or lab-based measurements were used, as the study focuses on macro-level agricultural performance analysis.

Limitations of Methodology

- The study relies on compiled datasets rather than real-time field measurements.
- Some states have extremely small cultivation areas (e.g., North-East India), limiting their comparative weight.
- Productivity differences are interpreted using existing scientific literature rather than experimental validation.

Ethical Considerations

All data was collected from authorized agricultural sources. No personal data or sensitive information was used. Interpretation remained strictly academic and objective.

RESULTS

Observations

The compiled state-wise data for the year 2023–24 revealed notable differences in pomegranate cultivation across the six major regions of India. The observations are presented through three comprehensive tables, each followed by analytical interpretations.

Table 1. Performance of Western & Central India (2023–24)

State	Area ('000 ha)	Production ('000 MT)	Productivity (MT/ha)	Remarks
Gujarat	43.53	629.02	14.45	Very high productivity
Madhya Pradesh	7.12	87.98	12.36	Moderate performance
Maharashtra	108.37	1422.50	13.13	India's largest producer
Regional Total	**159.01**	**2139.50**	**13.45**	Strongest region overall

This region emerged as India's primary pomegranate hub, contributing the largest share in both area and production. Maharashtra alone accounted for the majority of the country's output, consistent with literature highlighting its suitable semi-arid climate and high adoption of drip irrigation and fertigation (Intrigliolo et al., 2013; Saroj & Kumar, 2019). Gujarat demonstrated the highest productivity, supported by efficient water management and kaolin spray adoption, as previously observed by Melgarejo et al. (2004) and Al-Saif et al. (2022). Overall, this region shows high efficiency and commercial maturity in pomegranate cultivation.

Table 2. Performance of Southern India (2023–24)

State	Area ('000 ha)	Production ('000 MT)	Productivity (MT/ha)	Remarks
Andhra Pradesh	11.91	262.00	22.00	India's highest productivity
Karnataka	22.97	241.10	10.50	High area, moderate yield
Tamil Nadu	0.50	5.94	11.81	Niche-level cultivation
Telangana	0.88	11.01	12.58	Stable performance
Regional Total	**36.27**	**520.11**	**14.34**	Second highest productivity region

Southern India recorded the highest regional productivity, driven mainly by Andhra Pradesh's exceptional performance (22 MT/ha). This aligns with agronomic studies demonstrating strong crop response to micronutrient foliar sprays and fertigation in southern agro-climates (Davarpanah et al., 2016; Maity et al., 2021). Karnataka showed substantial area but only moderate productivity, indicating scope for improved nutrient and irrigation management. The southern region's overall performance reflects efficient practices, favorable climate, and increasing technology adoption.

Table 3. Performance of Northern, Eastern & North-Eastern India (2023–24)

Region	Area ('000 ha)	Production ('000 MT)	Productivity (MT/ha)	Remarks
Northern India	26.32	173.90	6.61	Low productivity
Hindi Belt	32.07	262.68	8.19	Sub-optimal performance
Eastern India	1.85	8.18	4.44	Lowest productivity
North-East India	0.08	0.42	5.60	Minimal contribution

These regions displayed consistently low productivity, ranging from 4.44 to 8.19 MT/ha—significantly below the national average. The observations align with earlier research highlighting climatic constraints, nutrient deficiencies and limited adoption of improved practices in these areas (Sharma et al., 2019). The Eastern region's extremely low productivity reflects a lack of commercial-scale cultivation, while Northern states show high variability due to temperature extremes and poor soil fertility. These findings indicate large potential for improvement through scientific interventions such as kaolin application, regulated deficit irrigation and micronutrient supplementation—supported by studies from Intrigliolo et al. (2013), Melgarejo et al. (2004), and Davarpanah et al. (2016).

Overall Observational Insights

1. Western–Central and Southern India dominate national pomegranate cultivation both in area and productivity.
2. Andhra Pradesh's productivity (22 MT/ha) stands out as a national benchmark for efficient cultivation.
3. Eastern and North-Eastern regions lag significantly, indicating structural and technological barriers.
4. Patterns strongly support the scientific literature on the importance of irrigation precision, nutrient management, and climate suitability.
5. Regional disparity suggests the need for targeted intervention policies and improved adoption of modern horticultural practices.

DISCUSSION

The results of the study reveal clear regional differences in pomegranate cultivation across India during 2023–24. Western–Central India emerged as the strongest production zone, contributing the largest share to national output, with Maharashtra alone accounting for over half of India's total production. Gujarat recorded one of the highest productivity levels, reaffirming the effectiveness of improved irrigation and canopy management practices. Southern India demonstrated the highest regional productivity, driven primarily by Andhra Pradesh, which achieved an exceptional 22 MT/ha, significantly surpassing the national average.

In contrast, Northern, Eastern and North-Eastern regions reported substantial productivity gaps, ranging from 4.44 to 8.19 MT/ha. These regions showed limited technological adoption and lower resource efficiency, which are consistent with previously identified agronomic constraints. Overall, the results confirm that productivity is closely linked to climate suitability, modern irrigation systems, nutrient management, and varietal selection.

CONCLUSIONS AND RECOMMENDATIONS

The present study provides a comprehensive assessment of India's regional disparities in pomegranate cultivation using state-wise data for 2023–24. The findings clearly establish that Western–Central and Southern India remain the most dominant regions, both in terms of area and productivity. Maharashtra, Gujarat, Karnataka and Andhra Pradesh collectively form the core of India's commercial pomegranate belt, supported by favourable agro-climatic conditions, improved irrigation infrastructure, and greater adoption of scientific crop management practices. The exceptionally high productivity recorded in Andhra Pradesh (22 MT/ha) reflects the positive impact of micronutrient management, fertigation, and efficient water regulation—an outcome consistent with published agronomic research.

In contrast, Northern, Eastern and North-Eastern regions continue to lag, primarily due to climatic constraints, suboptimal soil fertility, limited technological adoption and smaller cultivation areas. These regions present significant scope for improvement through the integration of practices validated by scientific studies—such as regulated deficit irrigation, foliar micronutrient

sprays, kaolin application for sunburn reduction, and adoption of high-performing cultivars.

Overall, the study highlights that while India possesses a strong production foundation, substantial regional inequality persists. Enhancing productivity in underperforming regions will require targeted extension services, infrastructure development, and widespread adoption of precision horticultural techniques. Strengthening these aspects will support balanced growth and bolster India's position as a leading global supplier of high-quality pomegranate.

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