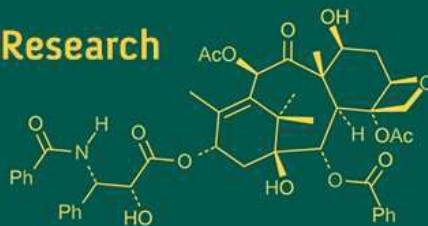


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; SP-9(11): 1382-1385
www.biochemjournal.com
Received: 20-09-2025
Accepted: 25-10-2025

Pooja Yaddanapudi
Ph.D. Scholar, Department of
Fruit Science, College of
Horticulture, Rajendranagar,
Sri Konda Laxman Telangana
State Horticultural University,
Hyderabad, Telangana, India

Kiran Kumar A
Professor (Horticulture)
OSD Telangana Oil Fed.,
Telangana, India

Sathish G
Assistant Professor (Sr. Grade),
PGIHS-Mulugu, Siddipeta,
SKLTGHU, Telangana, India

Yield, absorbed photosynthetically active radiation (PAR) and leaf area index (LAI) of mango varieties under ultra-high density planting system

Pooja Yaddanapudi, Kiran Kumar A and Sathish G

DOI: <https://www.doi.org/10.33545/26174693.2025.v9.i11Sq.7105>

Abstract

In the current study seventeen mango varieties were evaluated for Canopy volume, Leaf area, LAI, PAR and yield under ultra-high density planting system (3 × 2 m) with simple RBD design in Telangana state. The results revealed that yield was significantly and positively correlated with canopy volume, interception of PAR and LAI in ultra-high density planting system.

Keywords: LAI (Leaf area Index), PAR (Photosynthetically Active Radiation), Yield

Introduction

LAI is amount of leaf area per unit ground area which is important indicator of radiation, precipitation, interception, energy conversion and water balance. Since leaves are essential for photosynthesis and produce the bulk of biomass, the number of leaves also influence the yield. The relation between LAI and yield is however not simple, and will vary with the range of PAR is the amount of sunlight available for photosynthesis, which is light in 400 to 700 nanometers wavelength range. PAR changes seasonally and varies depending on the latitude and time of the day. The levels of PAR and LAI are most reliable to predict the tree yield which may vary with the canopy architecture of the tree.

Materials and methods

Varieties/ hybrids

Seventeen commercial/ popular mango varieties of Telangana viz., Alphonso, Amini, Amrapali, Baneshan, Dasher, Dasher-35, Himayat, Hydershab, Jalal, Kesar, Mahamoodavikarabad, Ratna, Royal special, Sindhu, Suvarnarekha, Swarna sindhura and Totapuri were evaluated under ultra-high-density planting.

Leaf area index

Leaf area index was calculated by using an instrument called digital plant canopy imager (CID Bio Science). Leaf area index is the ratio of foliage area to ground area. Canopy imager is having optical sensor consists with fisheye lens and an optical system. The fish eye lens sees a hemispherical image, which the optical system focuses onto the photodiode optical sensor, which is made up of five concentric rings. Leaf area index was taken five random points of each plant at vegetative state, flowering stage (BBCH-615) and harvesting stage (BBCH-810).

Interception of Photosynthetically active radiation (PAR)

Photosynthetically active radiation (PAR) was calculated with using an instrument called digital plant canopy imager (CID Bio Science.). PAR is photosynthetically active radiation having the wavelength ranging from 400-700 nm and is the portion of light spectrum utilised by plants for photosynthesis. It varies with season and crop. PAR was taken at five random points of each plant at vegetative state, flowering stage (BBCH-615) and harvesting stage (BBCH-810).

Corresponding Author:
Pooja Yaddanapudi
Ph.D. Scholar, Department of
Fruit Science, College of
Horticulture, Rajendranagar,
Sri Konda Laxman Telangana
State Horticultural University,
Hyderabad, Telangana, India

Results and discussion

LAI, PAR and yield of seventeen mango varieties under ultra-high-density planting

Canopy volume (cm³)

Canopy volume of tree was directly correlated with LAI and yield as the canopy volume represents leafiness and light interception of the tree.

Pooled data revealed that, considerably maximum canopy volume was observed in Totapuri (30.33 cm³) followed by Mahammoda vikarabad (26.13 cm³) and Kesar (25.60 cm³), while minimum canopy volume was observed in Amrapali (7.60 cm³) followed by Royal special (10.34 cm³) and Ratna (11.53 cm³).

Similar results were previously reported by Samant *et al.* (2020) [1] in mango Cv. Alphonso. They stated that canopy volume of tree was directly correlated with LAI and yield as the canopy volume represents leafiness and light interception of the tree.

Our findings are in agreement with Bakshi *et al.* (2012) [2] who evaluated eight mango varieties (*viz.*, Amrapali, Baramasi, Langra, Dasher, Mallika, Arun, Varun and Rajiv) under rainfed areas of Jammu and mentioned in their results that Langra variety recorded maximum tree volume (389.97 cm³) followed by Dasher (312.72 cm³), while Rajiv recorded minimum tree volume (29.44 cm³).

Leaf area (cm²)

It was evident from the pooled results that considerably maximum leaf area was observed in Suvarna sindhura (164.80 cm²) followed by Totapuri (153.50 cm²) and Alphonso (151.53 cm²), while minimum leaf area was observed in Jalal (81.17 cm²) followed by Kesar (82.49 cm²) and Baneshan (94.31 cm²).

These findings are in accordance with the results of Ahmed *et al.* (2016) [3]. They also evaluated five mango cultivars *viz.*, Kent, Keitt, Tommy Atkins, Heidi and Naomi and reported that Cv. Tommy Atkins recorded maximum leaf area (89.67 cm²) followed by Keitt (85.33 cm²), while minimum leaf area was recorded in Heidi (68.63 cm²).

Leaf area index (LAI)

The amount of leaf area per unit ground area is known as leaf area index. LAI is nothing but photosynthetic capacity of plant and it was positively correlated with tree yield of that plant. Optimized light distribution in canopy and its interaction with different parts is critical for enhancing photosynthesis, flower bud development, fruit development and color formation (Samant *et al.*, 2020) [1]. The results can be explained by the fact that since the young seedlings possess high root activity and high photosynthetic activity that cause increase of leaf area and dry-matter yield more than older one and hence resulted in higher PAR interception (Aggarwal and Singh 2015) [4].

As per the pooled data related to leaf area index, Totapuri cultivar recorded significantly maximum leaf area index (2.20, 4.49 and 4.01) followed by Kesar (2.13, 4.38 and 3.90) and Sindhu (2.08, 4.27 and 3.79), while Royal special

cultivar recorded minimum leaf area index (0.98, 3.01 and 2.42) followed by Ratna (1.07, 3.08 and 2.50) and Suvarnarekha (1.15, 3.19 and 2.59) at bud breaking phase (BBCH-513), flowering phase (BBCH-615) and at the time of harvesting (BBCH-810) respectively.

Present investigation results regarding leaf area index (LAI) indicated that an increasing trend from bud breaking phase to flowering phase and then decreased from flowering phase (BBCH-615) to harvesting time (BBCH-810).

Similar findings previously observed by Samant *et al.* (2020) [1] in mango Cv. Alphonso. They confirmed plant canopy volume, LAI and yield are interrelated with each other. Yield of mango trees showed an increasing trend with rise in both plant canopy volume and LAI. They reported that well pruned mango Cv. Alphonso recorded maximum canopy volume (155.02 cm³), LAI (1.26) and yield (48.76 kg/tree) than control.

Interception of Photosynthetically Active Radiation (PAR)

Results related to the photosynthetically active radiation (PAR) of seventeen mango varieties under ultra-high-density planting are highlighted in Table 1.

It was evident that considerably maximum photosynthetically active radiation (PAR) was recorded in Totapuri (77.07, 98.57 and 87.03) followed by Kesar (75.86, 98.38 and 87.03) and Sindhu (74.98, 96.44 and 85.09), while minimum photosynthetically active radiation was recorded in Royal special (57.26, 74.63 and 63.28), followed by Ratna (58.18, 74.71 and 63.36) and Suvarnarekha (59.32, 76.52 and 65.17) at bud breaking phase (BBCH-513), flowering phase (BBCH-615) and at the time of harvesting (BBCH-810) respectively.

Interpretation of pooled data related to photosynthetically active radiation (PAR) showed an increasing trend from bud breaking phase to flowering phase and then decreased from flowering phase (BBCH-615) to harvesting time (BBCH-810).

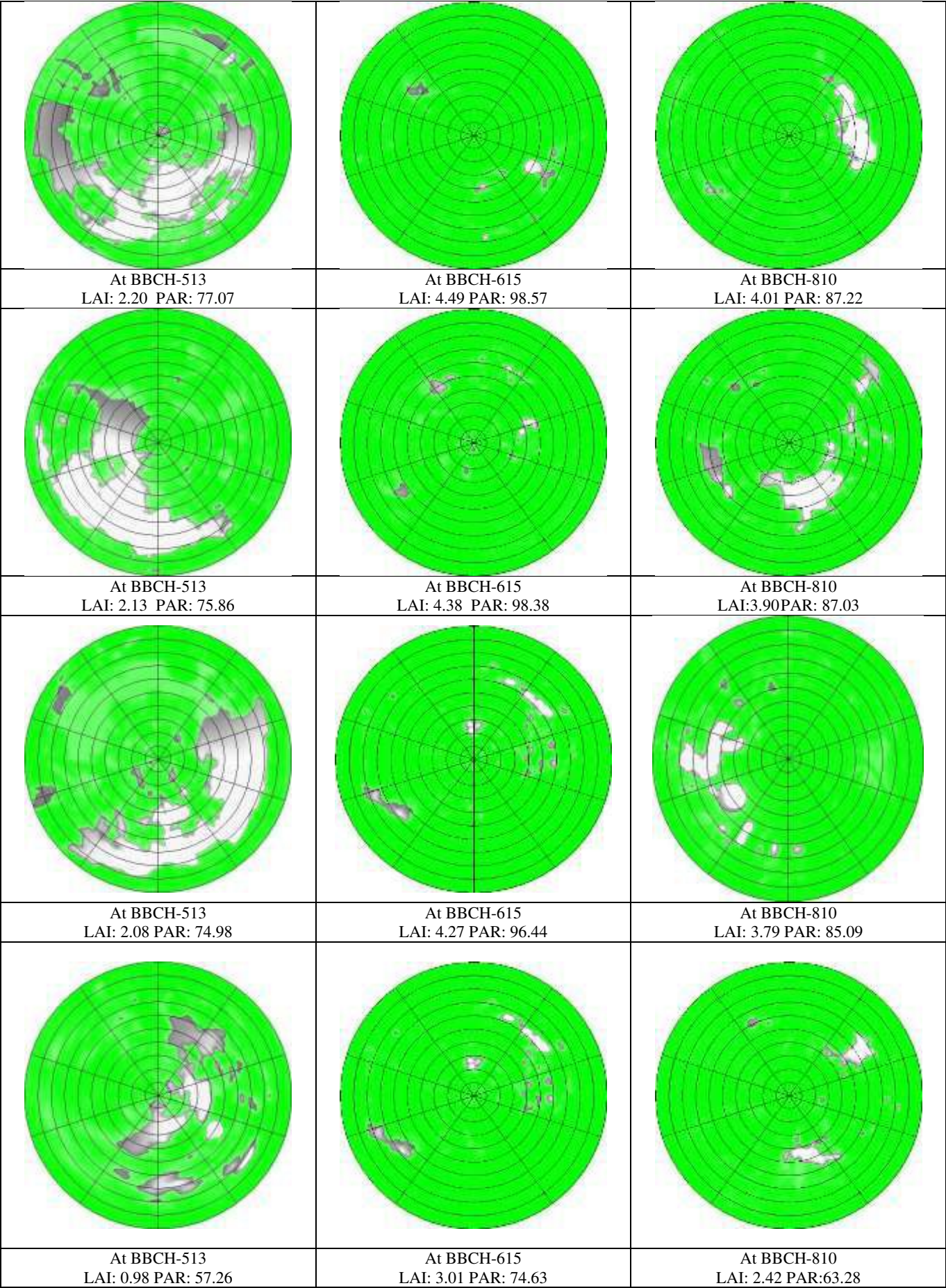
Fruit yield/tree (kg/tree)

The interpretation of data with respect to fruit yield revealed that, there was a significant variation among the mango varieties and fruit yield significantly varied among the seventeen mango varieties was ranged from 4.56 to 15.00 kg/tree given in table 1.

As per the pooled data, Totapuri variety recorded highest fruit yield (15.00 kg/ tree) followed by Kesar (13.83 kg/ tree) which was found to be on par with Sindhu (13.36 kg/tree), while lowest fruit yield was recorded by Royal special (4.56 kg/ tree) which was on par with Ratna (5.00 kg/ tree) followed by Suvarnarekha (5.99 kg/tree).

Correlation

It was identified from the data that, among the all seventeen varieties yield has significantly strong positive correlation with LAI (0.993**) and PAR (0.990**). Similar results were previously reported by Aggarwal and Singh (2015) [4].



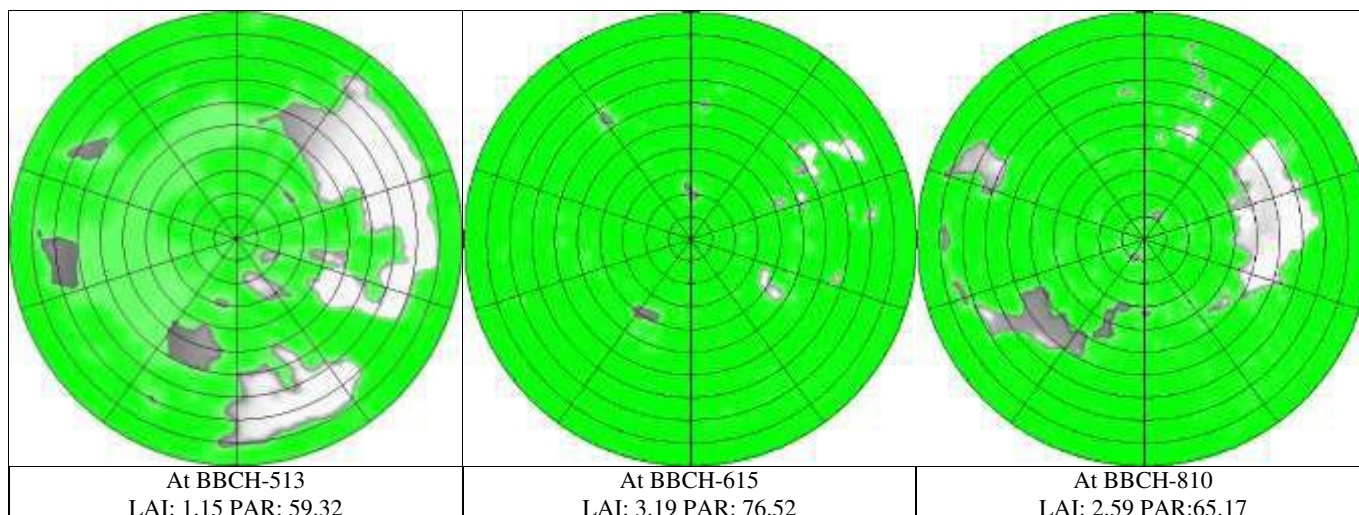


Plate 1: LAI and PAR at bud breaking (BBCH-513), flowering (BBCH-615) and harvesting (BBCH-810) phases of Totapuri, Kesar, Sindhu, Royal special and Suvarnarekha

Table 2: Mean LAI, interception of PAR and yield/tree (kg/tree) of mango (*Mangifera indica* L.) varieties under ultra-high density planting system

Varieties	Canopy Volume (cm ³)	Leaf area (cm ²)	Leaf area index (LAI)			Photosynthetically active radiation (PAR)			Yield (Kg/tree)
			BBCH-513	BBCH-615	BBCH-810	BBCH-513	BBCH-615	BBCH-810	
Alphonso	14.69	151.53	2.01	4.16	3.69	71.78	95.06	83.71	13.10
Amrapali	7.60	143.55	1.95	4.11	3.59	69.07	92.82	81.47	12.06
Baneshan	14.67	101.31	1.44	3.41	2.90	62.36	82.51	71.16	8.02
Dasheri	18.05	101.54	1.69	3.66	3.21	65.29	88.11	76.76	8.90
Dasheri-35	15.44	110.47	1.53	3.49	3.01	63.49	85.21	73.86	8.31
Himayath	19.61	105.32	1.89	3.97	3.50	67.78	91.48	80.13	10.45
Kesar	25.60	94.31	2.13	4.38	3.90	75.86	98.38	87.03	13.83
Mahammoda vikarabad	26.13	106.36	1.61	3.57	3.10	64.57	86.54	75.19	8.55
Sindhu	22.25	132.45	2.08	4.27	3.79	74.98	96.44	85.09	13.36
Suvarnarekha	12.92	82.48	1.15	3.19	2.59	59.32	76.52	65.17	5.99
Totapuri	30.33	153.49	2.20	4.49	4.01	77.07	98.57	87.22	15.00
Ratna	11.53	121.57	1.07	3.08	2.50	58.18	74.71	63.36	5.00
Suvarna sindhura	18.73	164.80	1.80	3.74	3.25	66.36	88.51	77.16	9.87
Amini	20.87	121.22	1.85	3.86	3.35	67.53	90.94	79.59	10.60
Hydersaheb	13.71	103.35	1.28	3.25	2.80	60.16	78.02	66.67	6.42
Jalal	14.15	81.17	1.35	3.32	2.78	61.29	79.94	68.59	7.23
Royal special	10.34	107.68	0.98	3.01	2.42	57.26	74.63	63.28	4.56
Mean	17.45	116.62	1.65	3.70	3.20	66.03	86.96	75.61	9.48
SE (m) ±	0.07	1.39	0.02	0.01	0.02	0.15	0.31	0.31	0.31
CD (5%)	0.21	4.12	0.06	0.03	0.06	0.45	0.91	0.93	0.92

Conclusion

The present investigation clearly demonstrated that mango productivity under the ultra-high density planting system (3 × 2 m) is strongly influenced by canopy architecture and light utilization parameters. Among the seventeen mango varieties evaluated, significant variation was observed in canopy volume, leaf area, leaf area index (LAI), interception of photosynthetically active radiation (PAR) and fruit yield. Varieties such as Totapuri, Kesar and Sindhu consistently recorded higher canopy volume, LAI and PAR interception, which resulted in superior fruit yield per tree. The study revealed a strong and significant positive correlation of yield with LAI and PAR, highlighting the crucial role of optimized canopy structure and efficient light interception in enhancing photosynthetic efficiency and yield under ultra-high density systems. LAI and PAR showed an increasing trend from bud breaking to flowering, followed by a decline towards harvest, indicating their dynamic nature across

growth stages. Overall, Totapuri emerged as the most promising variety, suggesting its suitability for ultra-high density planting in Telangana conditions.

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