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Agro-climatic adaptation and performance of thai mango varieties ('Nam Dok Mai' and 'Khieo Sawoei') under coastal Gujarat (Saurashtra region) conditions

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Abstract

The present study evaluates the agro-climatic adaptation, growth behaviour, yield attributes, and fruit quality of two Thai mango (*Mangifera indica* L.) varieties, 'Nam Dok Mai' and 'Khieo Sawoei', under coastal conditions of Gujarat (Saurashtra region), India. Planting was established in June 2021 following nursery acclimatization and managed using standardized organic-based practices. Observations recorded at the early bearing stage (after 5 years) were both cultivars showed successful planting with a uniformly vegetative growth habit; their average plant height was found to be ~3.1 m, and the canopy size was ~2.6 m. The average number of fruits per plant was found to be 54.4 to 55.4, and their yield averaged 19.7 to 20.5 kg per plant. Regarding the fruit quality criteria, fruits from both cultivars had exportable quality features; their average weight ranged from 357 to 366.8 g, while the Total Soluble Solids (TSS) content ranged from 17.4 to 19.32 °Brix. 'Nam Dok Mai' variety had relatively high TSS content, reflecting its better sweetness than that of other varieties. The findings highlight the potential of these varieties for diversification and commercial cultivation under coastal agro-ecosystems of Saurashtra region of Gujarat.

Keywords: Mango, Nam Dok Mai, Khieo Sawoei, Coastal Gujarat, yield, fruit quality, adaptation

1. Introduction

The mango tree (*Mangifera indica* L.) is one of the most crucial tropical and subtropical fruits that are extensively grown in South Asia, where India is the largest producer worldwide (FAOSTAT, 2023) [4]. The plant species is crucial for ensuring food nutrition security, providing income sources for rural communities, and generating foreign exchange earnings from exports owing to its high content of carbohydrates, vitamins, minerals, and phytonutrients (Tharanathan *et al.*, 2006; Bally, 2006) [1, 13]. However, despite its significant economic value, the production of mango fruits in India is primarily concentrated on a few cultivars that have been traditionally cultivated. This situation has resulted in problems such as a seasonal surplus, a narrow window for marketing products, and variable incomes among farmers (Singh *et al.*, 2011; Patel *et al.*, 2019) [9, 11]. Hence, diversification using high-value and early-maturing mango varieties becomes imperative to enhance profit and extension of harvesting period (Kumar and Sharma, 2020) [7].

Within this scenario, the Thai mango cultivars 'Nam Dok Mai' and 'Khieo Sawoei' have attracted international attention owing to their excellent fruit quality, appealing physical characteristics, minimal fiber content, high TSS, and export possibilities (Spreer *et al.*, 2009; Tongumpai *et al.*, 1991) [12, 14]. In particular, 'Nam Dok Mai' is highly regarded as an export mango variety and plays a crucial role in the mango export sector in Thailand (Spreer *et al.*, 2009) [12]. Additionally, these mango varieties possess early maturity and off-season production capabilities through proper management techniques (Diczbalis and Wicks, 2009) [3].

Mango varieties are highly dependent on environmental factors like temperature, humidity, and precipitation, which affect flower production, fruit set, and fruit growth (Whiley *et al.*, 1989; Davenport, 2007) [2, 15]. According to several investigations, the 'Nam Dok Mai' variety performs better in terms of its ability to adjust to diverse climatic situations and yield

generation than other varieties (Spreer *et al.*, 2009) ^[12]. The floral biology is another critical factor in determining yields. Research has found that the 'Nam Dok Mai' variety produces more hermaphroditic flowers, resulting in increased fruit set; on the contrary, the 'Khieo Sawoei' variety tends to bear fruit less frequently because of its fewer functional female flowers (Tongumpai *et al.*, 1991) ^[14].

Nutrient management is another important consideration that affects the yield and quality of mangoes is nutrient management. Micro-nutrients, especially boron, are necessary for reproductive growth, pollen germination, and fruiting. Nutritional deficiencies affect yields and cause physiological disorders like gummosis (Bally, 2006) ^[1]. Research has shown that boron is beneficial to plants and increases fruit formation in varieties such as Nam Dok Mai and Khieo Sawoei (Spreer *et al.*, 2009) ^[12]. Environmental factors like high soil salinity, sandy soil, wind, and humidity have their own unique impact on agro-ecosystem environments within Gujarat, which make the traditional practice of growing mangoes difficult (Patel *et al.*, 2018) ^[8]. Yet there is potential to cultivate exotic stress-tolerant mango varieties within such an ecosystem environment. Testing the suitability of Thai mango varieties in these agro-ecosystems could help increase the variety of mangoes grown, generate higher revenue, and improve marketing avenues, especially for off-season mangoes. However, due to the high commercial value of Thai mango varieties, there is an absence of scientific investigations related to the adaptation, performance, and yield behaviour of these varieties under coastal conditions in Gujarat. Thus, the current research was carried out to evaluate the adaptation, performance, and yield behaviour of 'Nam Dok Mai' and 'Khieo Sawoei' varieties under coastal conditions. Additionally, standardized practices for cultivation were also established in this research. The outcome of the current research expected to support the introduction of these varieties for adaption in the Gujarat's coastal agro-climatic region towards sustainable and profitable mango production in coastal regions.

2. Materials and Methods

2.1 Study area description

Study area is at Center for Agri-Horticulture, Manar, Ta: Talaja, Dist. Bhavnagar situated at 21° 42' N latitude, 72° 17' E longitude. It is the coastal area of South Saurashtra, which possesses a tropical semi-arid coastal climatic condition. Annual rainfall in the region is 598 to 670 mm, which occurs between June to September. Summers in the region are extremely hot, exceeding 40 °C, while winters are mildly cold. The soil type is medium to deep black soil while study area soil structure is clay loam type and suffering from salinity problems in coastal areas, irrigated by groundwater resources. Major crops of area include cotton, groundnut, wheat, and mangoes.

2.2 Planting Material Nursery Acclimatization

The planting material consist of total 10 plants (5 of each variety of Thai mangoes, namely 'Nam Dok Mai' and 'Khieo

Sawoei') (n =5) that were sourced from Thailand and transplanted in June 2021. After arriving, the planting materials were nurtured in a controlled nursery environment to ensure they would not experience transplant shock and were later exposed gradually to the local environment to acclimatise.

2.3 Land Preparation and Pit Management

The process of land preparation entailed digging of planting pits of 1 m × 1 m × 1 m and placing a bottom layer of stones to allow proper drainage in the coastal regions. The planting pits were filled with a carefully prepared growing medium, which included soil from the farm, cocopeat, vermicompost, vermiculite, perlite, peat moss, and Farm Yard Manure (FYM). Pre-planting irradiation of the planted pit was done by exposing it to sun for 15 days to naturally sterilize the environment, followed by pre-planting irrigation to ensure optimal moisture conditions for establishment.

2.4 Planting and Crop Management Practices

The crop planting was done under irrigation facilities (drip irrigation), and biological treatments involving *Trichoderma* species were used to improve root development and minimize soil-borne diseases (Harman *et al.*, 2004) ^[5]. In the first year, crop management involved ensuring proper rooting through liquid organic fertilizer applications and maintaining optimum soil moisture. In the second year, POP and SOP were followed with the use of organic materials, Jivamrut, which were produced by the Manar center (Kumar *et al.*, 2017) ^[6]. Pruning was conducted to maintain canopy structure and facilitate light penetration into plant parts, with integrated nutrients and pest management strategies being employed for crop sustainability (Ploetz *et al.*, 2015) ^[10].

2.5 Plant and fruit growth parameters measurement:

The variables used to assess growth and yield attributes include plant height, canopy cover, the number of fruits per plant, and yield per plant, which were measured at five years old plant during 1st fruiting growth stage. The physical attributes of the fruits including their length, weight, pulp content and %brix (brix meter 0-32%, Erma inc., Japan) were measured.

3. Results and Discussion

The performance of the Thai mango varieties 'Nam Dok Mai' and 'Khieo Sawoei' under coastal conditions of Gujarat demonstrated successful adaptation with comparable growth and yield attributes at the initial fruiting stage (5 years after planting). The average plant height was recorded as 3.14 ± 0.23 m in 'Nam Dok Mai' and 3.12 ± 0.16 m in 'Khieo Sawoei', while canopy spread was 2.64 ± 0.22 m and 2.66 ± 0.28 m, respectively (Table 1), indicating uniform vegetative growth under similar agro-climatic conditions. These findings are in agreement with earlier studies, which reported moderate vegetative vigor in Thai mango cultivars under tropical environments (Spreer *et al.*, 2009) ^[12], suggesting their suitability for high-density planting systems.

Table 1: Plant parameters (n=5) including age, height, canopy, spread, fruit no. & weight and yield per plant

Nam Dok Mai (plant no.)	age (year)	height (m)	canopy spread (m)	fruits per plant (no.)	Average fruit weight (gm)	total yield per plant (kg)
1	5	3.4	2.9	73	378	27.6
2	5	2.8	2.3	41	341	14
3	5	3.3	2.7	59	428	25.3
4	5	3.1	2.6	48	323	15.5
5	5	3.1	2.7	51	315	16.1
Average±S.D.		3.14±0.23	2.64±0.22	54.4±12.24	357±46.5	19.7±6.26
Khieo Sawoei (plant no.)						
1	5	3	2.4	46	317	14.6
2	5	3.2	2.9	57	415	23.7
3	5	2.9	2.4	41	360	14.8
4	5	3.3	3	69	363	25.1
5	5	3.2	2.6	64	379	24.3
Average±S.D.		3.12±0.16	2.66±0.28	55.4±11.8	366.8±35.4	20.5±5.31

The number of fruits per plant ranged from 41 to 73 in ‘Nam Dok Mai’ and 41 to 69 in ‘Khieo Sawoei’, with mean values of 54.4 ± 12.24 and 55.4 ± 11.8 fruits, respectively. Correspondingly, the total yield per plant was 19.7 ± 6.26 kg in ‘Nam Dok Mai’ and slightly higher (20.5 ± 5.31 kg) in ‘Khieo Sawoei’ (Table 1; Fig 1). The comparable yield levels between the two cultivars indicate their balanced reproductive performance under coastal stress conditions. These results are consistent with the findings of Tongumpai *et al.* (1991) ^[14], who reported similar fruiting behavior in Thai cultivars, although yield variability may occur due to environmental and management factors.

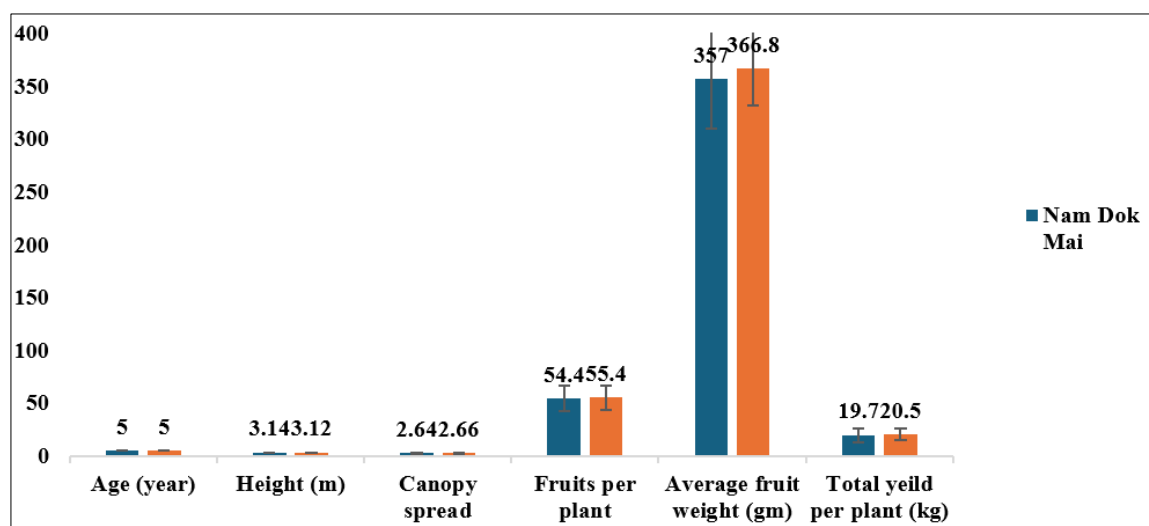
Fruit physical characteristics revealed that ‘Nam Dok Mai’ produced slightly longer fruits (21.2 ± 2.15 cm) compared to ‘Khieo Sawoei’ (20.32 ± 1.93 cm), while fruit diameter was marginally higher in ‘Khieo Sawoei’ (7.76 ± 0.84 cm) than in ‘Nam Dok Mai’ (7.6 ± 0.88 cm). The average fruit weight was 357 ± 46.5 g in ‘Nam Dok Mai’ and 366.8 ± 35.4 g in ‘Khieo Sawoei’, indicating comparable fruit size between the two cultivars (Table 2; Fig 2). These values fall within the reported range for export-quality Thai mangoes (300-

500 g), as documented by Spreer *et al.* (2009) ^[12], confirming that the fruit quality under Gujarat conditions meets international standards.

Table 2: Fruit parameters including length, diameter and %brix

Parameters	Nam Dok Mai	Khieo Sawoei
Length (cm)	21.2±2.15	20.32±1.93
Diameter (cm)	7.6±0.88	7.76±0.84
%Brix	19.32±0.88	17.4±1.2

Quality analysis showed that total soluble solids (%Brix) were higher in ‘Nam Dok Mai’ (19.32 ± 0.88) compared to ‘Khieo Sawoei’ (17.4 ± 1.2), indicating superior sweetness and consumer preference potential. Higher TSS in ‘Nam Dok Mai’ has also been reported in previous studies and is attributed to its genetic characteristics and efficient carbohydrate accumulation during fruit maturation (Bally, 2006) ^[1]. The relatively lower TSS in ‘Khieo Sawoei’ may be associated with varietal differences in sugar metabolism and fruit development.

**Fig 1:** Comparative analysis of both variety plants parameters (age, height, canopy, fruits, and no. & weight, yield per plant)

The overall results suggest that both Thai mango varieties performed well under coastal agro-ecosystems, despite challenges such as salinity, high temperature, and variable rainfall. The successful establishment and fruiting indicate effective acclimatization and the suitability of the adopted

agronomic practices, including organic nutrient management and canopy regulation. Similar observations have been reported by Davenport (2007) ^[2], who emphasized the importance of environmental adaptation and management practices in determining mango productivity.

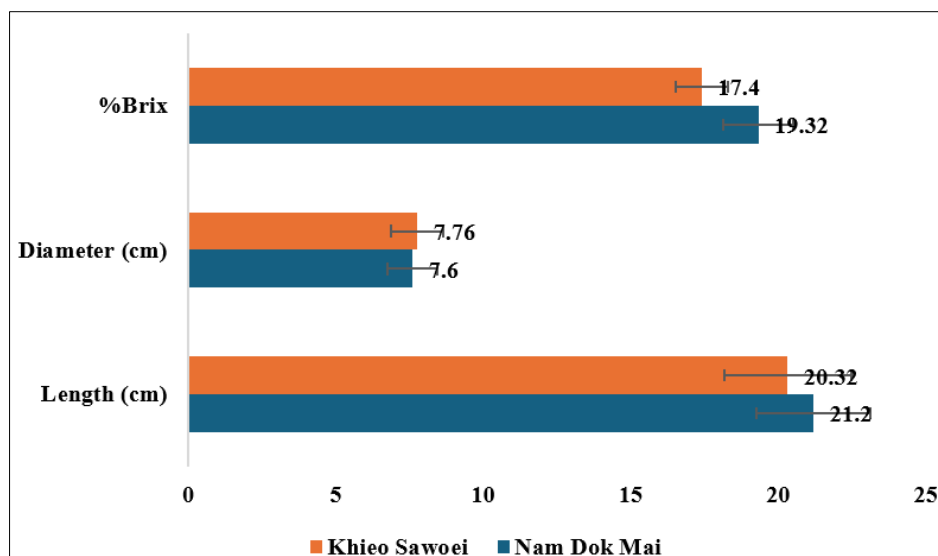


Fig 2: Comparative analysis of fruit parameters of both varieties including length, diameter and brix

Furthermore, the relatively stable yield and fruit quality observed in both cultivars during the initial bearing stage highlight their potential for commercial cultivation in coastal regions. The early fruiting behaviour and acceptable yield levels provide a competitive advantage over traditional

varieties, particularly in terms of market timing and export opportunities. However, as the plants are still in the early bearing phase, yield is expected to increase significantly with plant age, as reported in long-term mango productivity studies (Whiley *et al.*, 1989) ^[15].



Fig 3: Two varieties of mango plant with fruit (A: 5-year-old Nam Dok Mai, B: 5-year-old Khieo Sawoei, C: Fruits of Nam Dok Mai, D: Fruits of Khieo Sawoei)

In summary, the findings confirm that ‘Nam Dok Mai’ and ‘Khieo Sawoei’ are well adapted to coastal Gujarat conditions, exhibiting satisfactory growth, yield, and fruit quality parameters. Their performance aligns with global reports on Thai mango cultivars, indicating strong potential for diversification and commercialization in similar agro-climatic regions.

4. Conclusion

The present study clearly shows that the exotic Thai mango varieties ‘Nam Dok Mai’ and ‘Khieo Sawoei’ can be considered satisfactorily adapted, grown successfully, and yielding well under the climatic conditions of Gujarat. Uniform vegetative growth and similar yield were observed among both cultivars when they started to bear fruits, which also proved their exportable quality on the basis of their fruit quality characters. ‘Nam Dok Mai’ had slightly higher total soluble solids, which prove its superiority in sweetness, whereas ‘Khieo Sawoei’ performed similarly well on the basis of their yields and other yield characters. The

successful cultivation under stressful conditions and climatic variations proves that the adopted techniques of cultivation were effective and sustainable.

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