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Research Article

Performance Evaluation of Commercial Mango Varieties at Woreta in Fogera District, Northwestern Ethiopia

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Abstract

Cultivation of Mango is an important venture in Ethiopia especially in Amhara, Beneshangul, Oromia, and SNNP regions. However, challenges such as low yields and inconsistent fruit quality persist, particularly in Amhara region. This study was conducted to evaluate the performance of four commercial mango varieties at Woreta in the Fogera district of Amhara region. Four varieties viz; Tommy Atkins, Keitt, Apple Mango, and Kent were laid in a randomized complete block design with three replications. The Result showed significant differences among the varieties in terms of phonological and morphological traits. Tommy Atkins and Keitt took longer times to flower and maturity as compared to the Apple Mango, which matured earlier. Keitt revealed the tallest height and largest canopy diameter and contributed to the highest yield of 116.91 kg/plant, followed by Tommy Atkins (111.71 kg/plant). Apple Mango and Kent produced low yields with small fruit sizes but Apple Mango showed a higher unmarketable yield. Keitt's fruit also had an ideal size and makes it desirable for marketability. The analysis result highlights that Keitt and Tommy Atkins are the best-performing mango varieties in terms of yield and fruit size, whereas Apple Mango, despite its early maturity, may face quality issues affecting its marketability. These insights can guide growers in selecting the most suitable varieties to maximize both yield and fruit quality. To enhance mango production, further ongoing research should focus on optimizing irrigation, fertilization, and pest management practices, particularly against white-scale insects. Addressing these areas towards alleviating major constraints of production will help to improve yields and fruit quality, ultimately leading to better economic returns for mango producers.

Keywords

Mango, Fruit, Yield, Variety, Trait

1. Introduction

Mango also known as king of fruits belongs to the Anacardiaceae family and is classified as monoembryonic or polyembryonic. Monoembryonic varieties have one zygotic embryo, while polyembryonic varieties contain multiple embryos, with one being a weaker zygotic and others nuclear [13]. Polyembryony is genetically inherited and controlled by a single dominant gene. High temperatures during flowering and fruit development may cause monoembryonic varieties to produce polyembryonic seeds [15]. It is one of the most important tropical and subtropical fruit crops globally [14, 1]. Mango is extensively cultivated across tropical and subtropical regions for commercial purposes, home gardens, and as a shade tree [4]. Mango is native to Southern Asia, specifically Eastern India, Burma,

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and the Andaman Islands [8]. Mango propagation primarily occurs through seeds, and propagation by asexual methods like grafting is also common [6]. However, the development of new mango varieties poses challenges due to the tree's prolonged juvenile phase and high genetic heterozygosity. The slow and challenging process of improving mango varieties through breeding has been attributed to factors such as extended juvenile periods, genetic variability, polyembryony, natural fruit drop, and incompatibilities between varieties, which can take over 20 years [2]. Despite these difficulties, mango cultivation remains widespread, with numerous varieties adapted to various climates. These extensive plantations are vital to the economies of many tropical and subtropical regions. Mango's popularity as a fruit is driven by its exceptional nutritional profile, coupled with its distinctive flavor, fragrance, taste, color, and texture, making it a favored fruit worldwide [10].

Mango production ranks as the fifth largest fruit crop globally, following bananas, grapes, apples, and oranges [5]. It holds significant importance as the second most crucial tropical fruit crop in the world [5]. Ethiopia possesses extensive areas of land that are well-suited for mango cultivation, with the fruit primarily grown in the Oromia, Southern Nations, Nationalities, and Peoples' Region (SNNPR), Benishangul-Gumuz, Amhara, Harari, and Gambela regions [18]. Mango ranks second in total production and third in area coverage among fruit crops in Ethiopia that emphasizes its significance in the country's horticultural sector. This versatile tree species serves multiple purposes, including providing shelterbelts, firewood, timber, fruits, cattle fodder, green manure, and medicinal products. Mango is a critical fruit crop in the tropics, known for its nutritional benefits and its role in generating income for farmers. In Ethiopia, mango is particularly important, contributing significantly to the agricultural economy and the livelihoods of smallholder farmers. The Amhara region, in particular, is notable for its vast areas of land with suitable climatic conditions and abundant irrigation resources, making it an ideal area for mango production [17]. However, the average mango yield in the Amhara region, 3.5 tons per hectare, is substantially lower than the Ethiopian national average of 7 tons per hectare and the global average of 9.5 tons per hectare [3]. This yield gap highlights the potential for improving mango production practices in the region to enhance productivity.

In most parts of Ethiopia, mango trees are primarily propagated from seedlings, which often results in inferior productivity and fruit quality. To address these challenges, improved mango varieties, namely Kent, Keitt, apple mango, and Tommy Atkins were introduced in Israel in 1983. These varieties have since been multiplied and distributed across various regions of the country by the Upper Awash Agro-Industry Enterprise [9]. These improved varieties are highly favored due to their adaptability to local conditions, resistance to diseases, and high yield potential. For optimizing mango production and ensuring high-quality fruits, a comprehensive understanding of the flowering, fruit set, and harvesting periods of these improved varieties is essential. Proper management of these stages can significantly enhance the productivity and quality of mangoes, making them more competitive in both local and international markets.

Fruit setting in mango, following the flowering stage, is a critical factor that directly influences yield potential. This process is significantly affected by pollination efficiency, temperature, and humidity. In Ethiopia, mango flowering generally takes place during the dry season, from late December to March, with the timing heavily influenced by prevailing temperature and rainfall patterns. After the fruit set, mangoes typically enter a development and maturation phase lasting between 3 to 4 months, though this duration can vary depending on the specific variety and environmental conditions. The final stage in mango production is harvesting, where fruits are collected at their optimal maturity to ensure the best possible quality. Proper timing during this stage is crucial, as it affects the flavor, texture, and marketability of the fruit [16].

The adaptation and performance of different mango varieties can vary significantly depending on specific climatic and soil conditions [12]. This study aims to explore how various commercial mango varieties adapt and perform in the specific environmental conditions of the Fogera district in Northwestern, Ethiopia. By assessing factors such as growth rates, fruit yield, and yield-related traits, the research tried to identify which commercial mango varieties are best suited for cultivation in this region. The findings will provide valuable insights for local farmers and agricultural planners, potentially leading to more efficient and sustainable mango production practices in the Fogera District.

2. Material and Methods

2.1. Description of the Study Area

The study was conducted in the Fogera district, situated in the Amhara Region of Ethiopia. The site is situated at 11° 58′ N latitude and 37° 41′ E longitude. It has an elevation of 1819 meters above sea level and receives an annual rainfall of 1230 mm. The climate in the study area supports the growth of various crops. The temperature range is 12 ℃ to 28 ℃., which is conducive for mango flowering and fruit development thus promoting higher yields. The soil composition in the study area is predominantly clay loam, which is highly suitable for mango cultivation. Clay loam offers excellent drainage while retaining moisture and nutrients, making it ideal for the root systems of mango trees. The soil types a pH of 5.48 supports healthy tree growth, contributing to robust fruit production [11].

2.2. Planting Material with Agronomic Management and Experimental Design

Four mango varieties were considered in this study: Tommy Atkins, Keitt, Apple Mango, and Kent. Grafted seedlings of both varieties as planting materials were obtained from the Melkasa Agricultural Research Center. These varieties were chosen based on several criteria, including their popularity among growers, availability in the market, and established performance in similar agroecological zones. A randomized complete block design (RCBD) with three replications was employed. Each block consisted of four plots, with each plot dedicated to one specific mango variety. The dimensions of each plot were 8 meters by 8 meters. Each plot contained four plants of the same variety with inter- and intra-raw spacing of 4 m by 4m. Standard agronomic practices were uniformly applied across all plots to maintain consistency in management and care. This included regular irrigation, appropriate fertilization, and effective pest management strategies.

2.3. Data Collected

In this study, comprehensive data were collected on several key parameters to evaluate the growth and performance of the selected mango varieties. The parameters measured include:

Tree Height (Meter)

Tree height is a critical indicator of overall growth and vigor in mango cultivation. Measurements were taken from the base of each tree to the tip of the highest branch. This parameter helps assess how well each variety adapts to the local environment and contributes to yield potential.

Canopy Diameter (Meter)

Canopy spread refers to the horizontal extent of a tree's branches. This measurement is crucial for determining how much sunlight the tree can capture, which directly affects photosynthesis and fruit development. Assessing canopy spread provides insights into the tree's overall health and its capacity to compete for resources. Measurements were taken at the top part of the canopy using a measuring tape to gauge the horizontal reach accurately.

Flowering Time

The timing of flowering is crucial as it affects the subsequent fruit set and yield. Data were collected on the number of days from transplanting to the onset of 50% flowering for each variety. Understanding flowering time helps in predicting harvest periods and planning for management practices.

Fruit Maturity

In addition to recording flowering time, the duration from transplanting to fruit maturity was also recorded. This data is essential for determining the optimal harvest period, ensuring that the fruits are picked at their peak quality for maximum marketability.

Marketable yield per tree (kg/plant)

Marketable yield per tree is a fundamental measure of productivity in mango cultivation. Marketable fruit weight harvested from each tree was recorded, allowing for comparisons between the different varieties. This parameter is critical for assessing the economic viability of each variety.

Fruit Length and Width (centimeter)

The dimensions of the fruit, including both length and width were measured to evaluate fruit size. These measurements are important for market preferences, as larger fruits are often more desirable. The data collected on fruit dimensions can help determine the commercial potential of each mango variety.

3. Results and Discussion

Based on the mean results presented in the Table 1, the performance of four mango varieties was analyzed across several key parameters: days to flowering (DF), days to maturity (DM), tree trunk diameter (TT), marketable yield per plant (mrktyld), unmarketable yield (Unmktyld), fruit diameter (FD), fruit length (FL), plant height (PH), and canopy diameter (CD). The analysis of variance revealed significant differences among these parameters, as discussed below.

Days to Flowering (DF) and Days to Maturity (DM)

Tommy Atkins and Keitt exhibited the longest DF and DM (51.57 and 54.57 months for Tommy Atkins; 50.87 and 53.87 months for Keitt), indicating their longer growth period before flowering and maturity. In contrast, Apple mango showed the shortest DF and DM (33.87 and 36.87 months), suggesting faster development and early production capability (Kassim *et al*., 2016).

Tree Height (PH) and Canopy Diameter (CD)

Keitt had the tallest height (2.38 m) and a significant canopy diameter (2.35 m), indicating a robust growth habit that may enhance light capture and fruit development [19]. The second-best performance in canopy diameter (1.78 m) is from the variety Tommy Atkins while it is the third in terms of height (1.61 m) contributing to its overall vigor.

Marketable fruit Yield (YLD)

Keitt produced the highest yield (116.91 kg/plant), followed closely by Tommy Atkins (111.71 kg/plant). This aligns with previous research indicating that these varieties are high-yielding under suitable conditions (Nath and Subramanyam, 2018). The lowest yield is obtained from varieties Apple mango and Kent (98.35 kg/plant and 98.76 kg/plant, respectively), indicating that earliness in maturity of these varieties does not necessarily correspond to high yield.

Unmarketable Fruit Yield (Unmktfyld)

Unmarketable yield was highest from Variety Kent (5.8 kg/plant) followed by Apple mango (5.22 kg/plant), which may suggest higher susceptibility to fruit quality issues, possibly due to environmental sensitivity [7]. On the other hand,

the lowest unmarketable yield was from varieties of Tommy Atkins (1.86 kg/plant) and Keitt (2.9 kg/plant) highlighting the potential of these varieties for producing good quality fruit.

Fruit Dimensions

Fruit Diameter (FD) and Fruit Length (FL) were also assessed, with Keitt showing favorable dimensions (FD: 9.7 cm, FL: 11.01 cm). This suggests that the variety not only produces high yields but also large fruit sizes, which is desirable in the market. Tommy Atkins also had competitive fruit metrics, while Kent and Apple mango had smaller dimensions.

Table 1. *Mean performance of four commercial mango varieties' yield and yield-related traits.*

Varieties	DF (months)	DM (months)	TT (CM)	Mrktyld (kg/plant)	Unmkftyld (kg/plant)	FD (CM)	FL (CM)	PH (m)	CD (M)
Tommy atkins	51.57	54.57	4.59	111.71	1.86	9.5	8.71	1.61	1.78
Keitt	50.87	53.87	4.86	116.91	2.9	9.7	11.01	2.38	2.35
Apple mango	33.87	36.87	4.37	98.35	5.22	7.84	7.54	1.56	1.47
Kent	41.1	44.1	6.96	98.76	5.8	7.84	7.82	1.87	1.27
CV	6.29	5.89	16.89	5.61	10.63	9.05	4.57	5.76	8.61
LSD	5.58	5.58	1.75	11.93	0.84	1.58	0.8	0.21	0.3
SGN.	**	**	*	**	***	*	***	**	**

Key: DF = month of flowering; MD = month of maturity; TT = trunk thickness; Mrktyld = marketable fruit yield; Unmrktfyld = unmarketable fruit yield; FD = fruit Diameter; FL = fruit Lnength; PH = plant height and CD = canopy diameter; CV = coefficient of variation; LSD = least significance difference; kg = kilogram; CM = centimeter; M = meter and SGN = significance

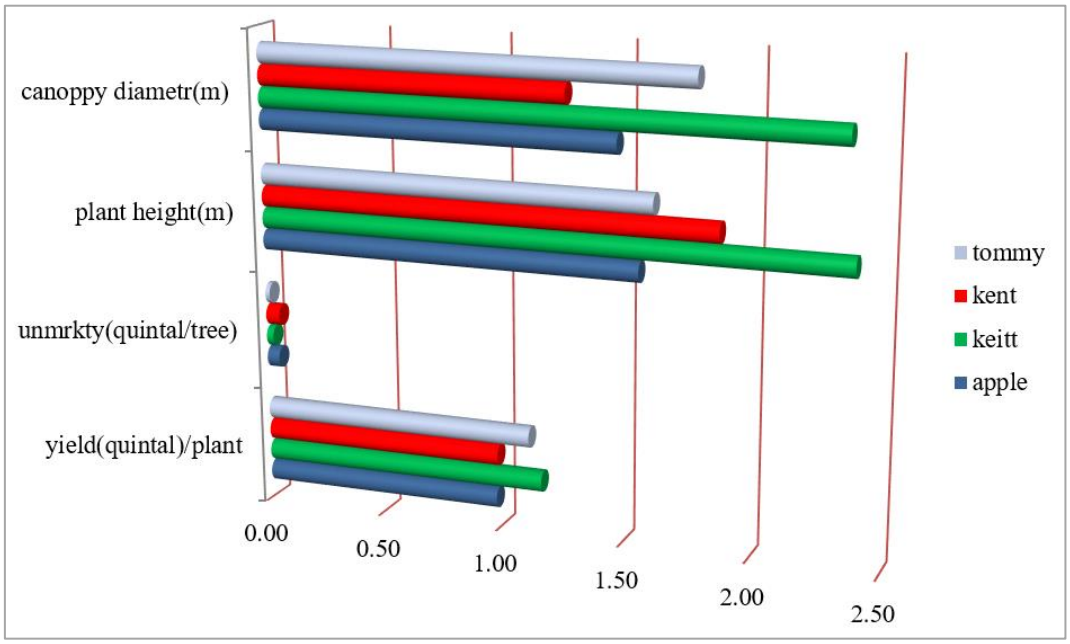

Figure 1. *The relationship between canopy height and yield traits of four mango varieties.*

Overall performance testifies that variety Keitt excelled in marketable yield, canopy diameter, and plant height, together with low unmarketable yield. Tommy Atkins ranked second in marketable yield and performed well in canopy diameter, though it did not lead in plant height. Kent mangoes had the highest unmarketable yield and the second tallest with moderate results in marketable yield and canopy diameter. Apple mangoes had the lowest marketable yield and shortest plant height, while having high unmarketable yield as comparable to Kent.

Figure 2. *Four mango varieties' fruit shapes, sizes, and colors at the maturity stage.*

4. Conclusion and Recommendations

Varieties Keitt and Tommy Atkins are identified as the top performing mangoes in yield and size, while Apple mango, despite its early maturity, may face quality issues affecting marketability. These findings may guide growers in variety selection to optimize yield and fruit quality. Further research is essential to refine irrigation techniques, develop effective fertilization strategies, and implement robust pest management practices, particularly against white-scale insects. Addressing these major challenges of production will help mango producers enhance yields and fruit quality thus leading to improved economic returns and success in mango farming.

Abbreviations

RCBD	Randomized Complete Block Design
PH	Potential of Hydrogen
SNNRP	Southern Nations, Nationalities, and Peoples' Region

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Author Contributions

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Conflicts of Interest

The authors declare no conflicts of interest.

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