

Growth and Yield Performance Evaluation of Mango (*Mangifera indica* L.) Varieties in Adola Rede District, Guji Zone, Southern Ethiopia

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Abstract: The study was conducted in Adola Rede District, Guji Zone, in Southern Ethiopia. The objective of the study was to evaluate Mango (*Mangifera indica* L.) varieties for their vegetative growth and yield performance. The treatments consisted of four mango varieties and the trial was laid out in randomized complete block design (RCBD) with three replications. A plot size of 10mx6m was used and each plot consisted of two rows of grafted mango seedlings. On each row three grafted mango seedlings were planted and each plots had six mango trees. This study showed that, regarding vegetative growth parameters significant differences ($P < 0.05$) were observed between mango varieties. Based on their survival rate, Keitt variety was significantly higher than the others and the least survival rate was recorded from Apple mango variety. Significantly the tallest tree height (4.693m) was recorded from Kent variety followed by Tommy Atkins (3.557m). Whereas, the shortest tree height was recorded from Keitt variety (2.65m). In terms of canopy spread, the maximum (4.14m) and (3.95m) were recorded from Tommy Atkins and Kent varieties respectively. While, the minimum canopy spread of (2.27m) was scored from Keitt variety. The longest fruit length of (13.87cm) was scored from Keitt variety and from the others statistically similar fruit length was recorded. The highest fruit width of 10.567cm and 9.767cm were obtained from Keitt and Apple mango varieties respectively. Whereas, the lowest values of fruit width were found in Tommy Atkins (6.533cm) and Kent variety (7.21cm). The largest fruit weight was recorded from Keitt (614.1gm) followed by Kent (493.8gm) variety. However, the lowest fruit weight was obtained from Tommy Atkins (388.3gm) and Apple mango (396.4gm). The maximum yield per tree (7.943kg) was recorded from Kent variety followed by Apple mango (6.173kg/tree). Regarding number of fruits per tree, Kent and Apple mango varieties produced highest number of fruits per tree (96.67) and (70) respectively. The maximum yields per plot were recorded from Kent (47.9kg) and Apple mango (47.41kg). Whereas, from Tommy Atkins and Keitt varieties lower number of yield per plot (27.92kg) and (12.72 kg) were scored respectively. In general, the maximum fruit yields per hectare were obtained from Kent (7,983kg) and Apple mango (7,901kg). However, the minimum yields/ha were recorded from Tommy Atkins (4,320 kg) and Keitt variety (2,120kg). Therefore, depending on their yield performances Kent and Apple mango varieties were recommended for mango producers of the study area and for similar agroecologies.

Keywords: Mango, Variety, Vegetative Growth, Yield Performance

1. Introduction

Mango (*Mangifera indica* L.) is a fleshy stone fruit belonging to the panes *Mangifera*, consisting of numerous tropical fruiting trees in the flowering plant family of Anacardiaceae [1]. It is a highly seasonal tropical fruit, very

popular among millions of people in the tropics and occupies a prominent place among the best fruits of the world [2]. The origins of Mango fruit tree is believed to be from South East Asia and over 1000 varieties have been identified all over the world and it is grown in more than 85 countries of the world with annual production of 35 million tons [3, 4].

Mango (*Mangifera indica* L.) is among the most important fruit crop in the tropical and subtropical regions of the world. It is cultivated approximately on 3.7 million hectares worldwide, occupied the 2nd position among the tropical fruit crops and 5th from fruit crops of the world after citrus, banana, grape, and apple [5, 6]. The fruit is considered important because it provides; income, nutrition security and health to smallholder farmers and consumers at large [7].

In Sub-Saharan Africa, growing both domesticated and wild fruit species on farms diversifies the crop production options of small-scale farmers and can bring significant health, ecological and economic revenues [8]. Mango (*Mangifera indica* L.) is known as the king of the fruits due to its excellent flavor, delicious taste and high nutritive values that makes the crop valued for both food and nutritional security especially for developing countries like Ethiopia where the realization of food and nutritional security is still a challenge [9].

Mango (*Mangifera indica* L.) is one of the most widely grown among the fruit crops cultivated in Ethiopia preceded only by banana in terms of economic importance and a total of 69,743.39 tons of mango is produced from 12,799 ha of land [10, 11]. Moreover, there are ample garden mango trees in different parts of the country at farmer's holdings. The livelihood of most of these farmers is highly supplemented by the sale of mango fruits [12]. It is grown in several parts of the country where the western and eastern Ethiopia are among the major producing belt that accounts >50% of the total mango production in Ethiopia [10].

For Mango (*Mangifera indica* L.) production Ethiopia has

great potential of suitable land and favorable climatic condition. Mango (*Mangifera indica* L.) is mainly produced in Oromia, SNNPR, Benishangul Gumuz, Amhara, Harari and Gambela regions [13]. However, production of Mango in Ethiopia is in fluctuated conditions, because of shortage of improved varieties, lack of proper management, occurrence of diseases and lack of knowledge and skills on the production of grafted mango seedlings [14].

More than 47 thousand hectares of land is under fruit crops in Ethiopia. Mangoes contributed about 12.61% of the area allocated for fruit production and took up 12.78% of fruit production in comparison to other fruits growing in the country. The annual consumption of mango by the processing plant at full production capacity is 8.6 tones which is only 1.8% of the current production of mango [15].

In Midland Agro-ecology of Guji Zone, in Southern Ethiopia production of Mango (*Mangifera indica* L.) is mainly constrained by lack of adaptable, high yielding and better quality of improved mango varieties. Likewise, available information on growth and yield performance evaluation of Mango (*Mangifera indica* L.) varieties for Midland Districts of Guji zone has not been generated so far. Thus, introduction of adaptable and disease resistance improved Mango (*Mangifera indica* L.) varieties can be one of the strategies to increase production of mango in the study area. Therefore, this study was initiated to evaluate vegetative growth and yield performances of improved Mango (*Mangifera indica* L.) varieties for Adola Rede District and similar agro-ecologies.

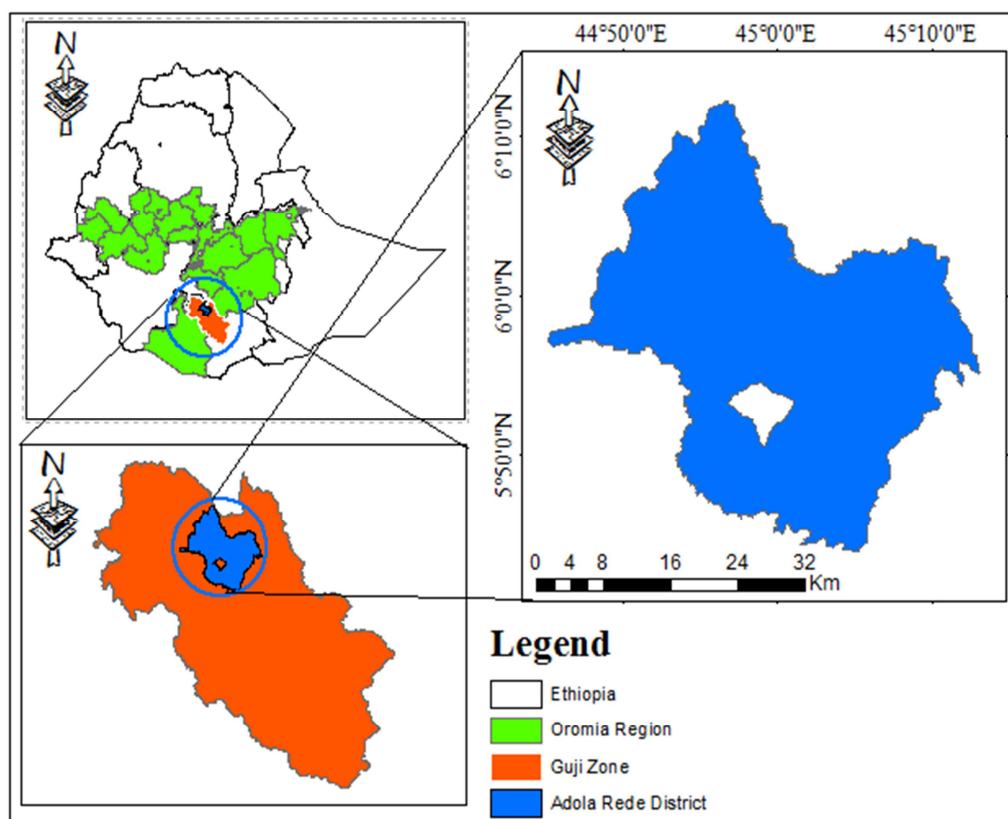


Figure 1. A map showing the study site.

2. Materials and Methods

2.1. Description of the Study Area

The experiment was conducted in Adola Sub-Site, Guji Zone, Oromia National Regional State, in Southern Ethiopia. The experimental site is found at a distance of 475 km from Addis Abeba, the capital city of Ethiopia. The study area is located within the North latitude of between 5°44'10"- 6°12'38" and East longitude of 38°45'10"- 39°12'37" (Figure 1).

Adola Rede District is characterized by three agro-climatic zones namely humid, sub humid and dry arid zones. According to climatic record data of the study area the mean annual maximum and minimum temperatures are 23°C and 16°C, respectively.

The type of rainfall of the study area is bimodal with longest rain season that has the maximum rainfalls which falls between 1200-1800mm annually and the shortest rainfalls records between 800-1200mm with an erratic distribution patterns. The dominant soil types found in the area are Nitisols and Orthocacrosols and it is dominantly brown soil. Moreover, the study area has an elevation ranging from 1500 m above sea level in the southern part of the district. However, in the north-western part of the district, it has an elevation greater than 2000 m above sea level.

The farmers of the study district produce both in autumn and spring seasons. The traditional farming system of the study area is characterized by cultivation of major crops such as teff, bread wheat, food barley, maize, haricot bean, lentils, chick pea and sweet potato. Farmers of the study district also engaged in the production of coffee as means of livelihood.

2.2. Experimental Design and Layout

Four Mango (*Mangifera indica* L.) varieties namely Apple, Keitt, Kent and Tommy Atkins were used for this study. Grafted seedlings with the same age of these four mango varieties were planted in Adola Sub site using a randomized complete block design (RCBD) with three replications. The appropriate types of grafted seedlings of mango varieties were planted in a well-prepared hole with a depth, diameter and width of 50, 50 and 50 cm, respectively. A plot size of 10mx6m was used and each plot consisted of two rows of grafted mango seedlings. On each row three grafted mango seedlings were planted and each plots had six grafted mango trees. Distance between the mango trees in the same row was 4m and distance between rows in the same plot was also 4m. The space between each plots and blocks was 1.5m and 2m respectively.

2.3. Field Management

For grafted seedlings of mango varieties planted at Adola sub site, all field management practices such as manure, mulching, watering supply, weeding and necessary plant protection were performed during the study time.

2.4. Data Collection

2.4.1. Growth Parameters

Vegetative growth parameters data like survival rate, tree height, stem thickness and canopy spread were collected during the study period.

2.4.2. Yield Parameters

From yield and yield components, necessary data such as fruit length, fruit width, fruit weight, fruit number/tree, fruit yield/tree and fruit yield/plots were collected during the study time.

2.5. Data Analysis

The analysis was performed by using Genstat 18th Edition. Vegetative and yield data recorded from each Mango (*Mangifera indica* L.) varieties were subjected to analysis of variance and Least significance differences (LSD) tests to enable comparison of the mango varieties.

3. Results and Discussion

3.1. Vegetative Growth Parameters

3.1.1. Survival Rate (%)

The present study indicated that, in terms of their survival rate significance differences ($P<0.05$) were showed between the Mango (*Mangifera indica* L.) varieties. In comparison with the others varieties, survival rate of Keitt mango variety was significantly higher ($P<0.05$). The recorded survival data of the four Mango (*Mangifera indica* L.) varieties of current study revealed that; Keitt variety was the higher (88.87%) followed by Kent (72.23%) and Tommy Atkins varieties (72.23%). While, survival rate of Apple mango was only 38.1% (Figure 2). The mango varieties studied revealed different growth performance in terms of survival rate was due to the varietal nature and environmental influence. Similar to this study results, former study findings conducted in India indicated that both the environment and genotype interactions are responsible for the control of vegetative growth parameters [16].

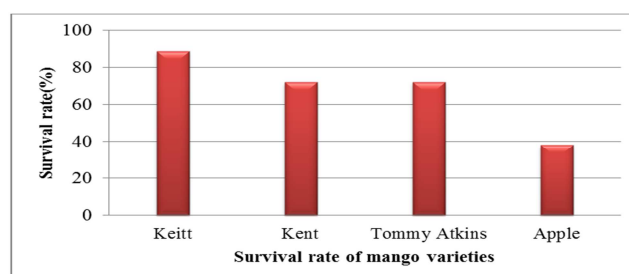


Figure 2. Survival (%) for Keitt, Kent, Tommy Atkins and Apple mango varieties.

3.1.2. Stem Thickness (cm)

Based on the findings of this study, the recorded stem thickness of mango varieties ranged from 14.23 cm (Kent) to

10.14 cm (Apple mango) with average of 12.07 cm stem thickness. As compared to the others mango varieties used on this study, Kent and Tommy Atkins varieties were significantly

higher ($P < 0.05$) than Keitt and Apple mango varieties (Table 1). However, statistically significance differences ($P < 0.05$) were not observed between Keitt and Apple mango varieties.

Table 1. Vegetative growth parameters such as Survival rate, Tree height, Stem thickness and Canopy spread of Kent, Keitt, Tommy Atkins and Apple mango varieties at Adola Rede District, Guji Zone, Southern Ethiopia.

Treatment	Vegetative growth performance parameters			
	Survival rate (%)	Tree Height (m)	Stem Thickness (cm)	Canopy Spread (m)
Kent	72.23 ^b	4.693 ^a	14.23 ^a	3.95 ^a
Keitt	88.87 ^a	2.650 ^c	10.14 ^b	2.27 ^b
Tommy Atkins	72.23 ^b	3.557 ^b	13.18 ^a	4.14 ^a
Apple mango	38.09 ^c	2.82 ^{bc}	10.72 ^b	2.61 ^b
Mean	67.8	3.453	12.07	3.24
CV (%)	21.9	8.6	5.5	6.9
LSD (5%)	28.64	0.557	1.238	0.424

*Means values in the same column with the same superscript are not significantly different at ($P < 0.05$) level.

*Means values in the same column with different superscript are significantly different at ($P < 0.05$) level.

3.1.3. Tree Height (m)

In terms of tree height increments significant differences ($P < 0.05$) were observed among the mango varieties (Table 1). As compared to the others, tree height of Kent mango variety was significantly higher ($P < 0.05$). The tallest tree height (4.693m) was recorded from Kent mango variety and the shortest tree height (2.65m) was observed from Keitt variety. The result of this study is in contrast with the finding which was conducted under rainfed areas of Jammu. On their study results reported that maximum plant height (5.82m) and minimum plant height of (2.93m) was recorded from mango varieties [17]. The finding of this study also contradicted with study results who reported maximum plant height of 7.55m from Pairi mango variety and lowest plant height (2.53 m) from Karel mango variety under sub-montane zone of Maharashtra [18].

The mango varieties their growth and yield performances studied showed different in tree height increments was due to varietal nature and environmental influence of the study area. Similar to this study finding, related views was reported that both the environment and genotype interactions are responsible for the control of tree height [16]. Moreover, earlier findings conducted on evaluation of mango hybrids for Kymore Plateau of Madhya Pradesh reported that the differences in the tree height of mango cultivars could be due to pruning, varietal nature and environmental influence [19].

3.1.4. Canopy Spread (m)

In this study finding, a significant variations ($P < 0.05$) was observed in terms of canopy spread between the mango varieties (Table 1). During the study time, Kent variety had larger canopy spread of 3.95 m. While the least canopy spread was recorded on variety of Keitt (2.27m). The finding of current study was in contrary with the former study results who reported that highest and minimum canopy spread of 8.09m and 2.57m was recorded respectively from mango varieties [17]. Previous study results conducted on Evaluation of Mango hybrids and Varieties under Telangana region of Andra Pradesh and In Madhya Pradesh also reported the variation in tree canopy spread of mango

cultivars [20, 21].

3.2. Yield Parameters

3.2.1. Fruit Length (cm)

In terms of fruit length, a significance differences were observed between the mango fruit tree varieties (Table 2). The greatest fruit length (13.87cm) was recorded from Keitt mango variety and the shortest fruit length (9.60cm) was found in Tommy Atkins variety. The present study indicated that, fruit length of Keitt mango variety was significantly ($P < 0.05$) higher than the others mango varieties. However, statistically a significance differences were not observed between Apple mango, Kent and Tommy Atkins varieties.

3.2.2. Fruit Width (cm)

Regarding of fruit width significance variations was recorded between the mango varieties used on this study. The highest (10.567cm) fruit width was found in Keitt variety followed by Apple Mango (9.767cm). While, the minimum fruit width of (6.533cm) was recorded from Tommy Atkins variety (Table 2). The main reason for differences in fruit width among the mango varieties could be due to fruit size is mainly determined by the number of cells per fruit and their subsequent enlargement and both factors are affected by the competition for carbon between developing fruits as crop load increases [22].

3.2.3. Fruit Weight (g)

A marked variation was found in fruit weight among the four mango varieties their growth and yield performances was conducted in the study area. The highest individual mean fruit weight was obtained from variety 'Keitt' (614.1g) followed by 'Kent' (493.8 g) and the lightest mean fruit weight was recorded from 'Tommy Atkins' (388.3g) (Table 2). This variation of fruit weight between mango varieties might be due to genetic differences, management practice and environmental situations of the study area. In agreement with current study findings, similar observations which was previously conducted indicated that the fruit weight of Mango (*Mangifera indica* L.) depends on varietal nature, cultural practices and climatic conditions of the growing

region of mango varieties [23, 24].

In terms of fruit weight recorded, the finding of this study was contradicted with the study result which was conducted on performance of mango cultivars grown in different Agro-Ecological Zones of Bangladesh. On their study findings reported that maximum and minimum fruit weight of 648 g and 130g was recorded respectively from mango cultivars [25]. The result of this study also contradicted with the study

finding which was reported that the maximum fruit weight (408.87g) and the minimum fruit weight of (175.38g) from mango varieties [26]. Therefore, from the finding of current and previous study results conducted in different countries observed that fruit weight of mango influenced by cultivars and varietal characteristics, management practice and agro-ecology of the growing area.

Table 2. Yield performance parameters such as Fruit length, Fruit width, Fruit weight, Fruit number/tree, Yield/tree, Yield/plot and Yield/hectare of improved Mango varieties at Adola Rede District, Guji Zone, in Southern Ethiopia.

Treatment	Yield and yield components performance parameters						
	Fruit Length (cm)	Fruit Width (cm)	Fruit Weight (g)	Fruit No/Tree	Yield/Tree (Kg)	Yield/Plot (kg)	Yield/Hectare (kg)
Kent	10.60 ^b	7.210 ^b	493.8 ^{ab}	96.67 ^a	7.943 ^a	47.90 ^a	7983 ^a
Keitt	13.87 ^a	10.567 ^a	614.1 ^a	35.67 ^c	2.093 ^d	12.72 ^d	2120 ^d
Tommy Atkins	9.60 ^b	6.533 ^b	388.3 ^b	46.67 ^{bc}	4.320 ^c	27.92 ^c	4320 ^c
Apple Mango	10.37 ^b	9.767 ^a	396.4 ^b	70.00 ^b	6.173 ^b	47.41 ^a	7901 ^a
Mean	11.11	8.52	473	62.2	5.13	33.49	5581
LCD (5%)	1.152	0.765	109.6	16.92	9.1	5.73	954.3
CV (%)	5.5	4.8	12.3	14.4	0.876	9.1	9.2

* Means values in the same column with the same superscript are not significantly different at ($P < 0.05$) level.

*Means values in the same column with different superscript are significantly different at ($P < 0.05$) level.

3.2.4. Number of Fruits/Tree

There was marked differences in fruit number per tree was observed between the mango fruit tree varieties. The recorded number of fruits per tree ranged from 46.67 to 96.67 and the maximum fruit number per tree was found in Kent variety followed by Apple mango. While, the minimum fruit number per tree was recorded from Tommy Atkins variety. Similar to this study results, previous findings also showed that fruit number per tree was negatively related to the fruit size in weight basis. Moreover, fruit size and total fruit yields are affected by crop load and the differences among cultivars are affecting negatively the mean fruit weight [27, 28]. Likewise, the finding of this study is in agreement with the study results carried out in Lake Victoria Crescent Region of Uganda reported that, in terms of fruit number per tree significance differences were recorded between the mango genotypes [29].

3.2.5. Fruit Yield/Tree (Kg/Tree)

Based on the findings of this study, regarding fruit yield per tree a significance differences ($P < 0.05$) were observed between the mango varieties. The highest fruit yield/tree was recorded from Kent variety (7.943 kg/tree) followed by that of Apple mango variety (6.173kg/tree). However, the minimum fruit yield per tree (4.320 kg/tree) and (2.093 kg/tree) were recorded from Tommy Atkins and Keitt mango varieties respectively. The variation of yields between mango varieties could be due to the yield is a highly variable factor depending upon the cultivars and age of the plants, climatic conditions, incidence of the pests and diseases [30]. Furthermore, the variation in yield per tree may be attributed to fruit size and weight of different genotypes studied. Direct relationships between fruit set and yield per tree also contributes to increase in mango yield under ideal environmental conditions [31].

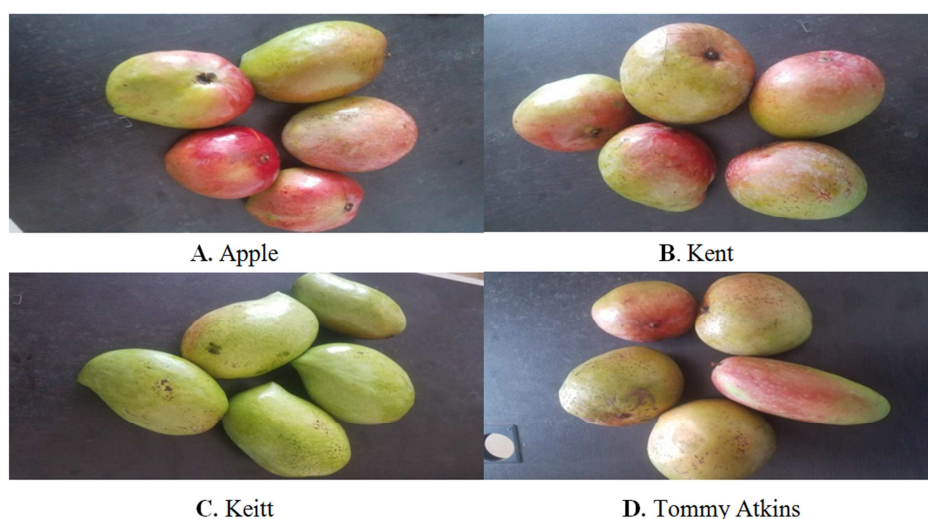


Figure 3. Harvested yield performance of Mango (*Mangifera indica* L.) varieties.

3.2.6. Yield/Plot (kg)

The results of present investigation in terms yield per plot showed that, significance differences were observed among the mango varieties (Table 2). The mean maximum yield of 47.90 kg/plot was recorded from Kent variety followed by Apple mango (47.41kg/plot). Whereas, variety Keitt showed mean lower yield of 12.72kg/plot. The variability of yield per plot between the mango varieties might be due to genetic variation of the varieties as well as strong influence of environment and cultural factors. Consistent with this study results, similar views was reported that the variation between yields of different mango genotypes may be attributed to the difference in agroecology and the cultivars under study as fruit set is a varietal character, based on the time of flowering, sex ratio, efficient cross pollination, and intensity of fruit drop leads to varying fruit set in different varieties [32].

3.2.7. Yield/Ha (kg)

In terms of yield per hectare significant variations were observed between mango fruit tree varieties their growth and yield performance was studied. In comparison with others varieties, the recorded mean yield per hectare of Kent and Apple mango varieties were significantly higher. Kent and Apple mango varieties had the highest yield per hectare of 7,983kg and 7,901kg respectively. However, Keitt mango variety had the minimum fruit yield of 2,120kg/hectare. Similar to this study finding, earlier study results indicated that the yield varies based on the age of fruit tree, cultivars, weather, location and other external factors. Moreover, the level of yield per hectare of fruit tree varieties varies based on effective pollination, crop husbandry practices and cultivars [33, 34].

4. Conclusion and Recommendation

Mango is one of the most widely grown among the fruit crops cultivated in Ethiopia preceded only by banana in terms of economic importance. However, its potential has not yet been fully utilized due to occurrence of diseases, lack of proper management and shortage of improved mango (*Mangifera indica* L.) varieties. Based on the findings of current study, in terms of vegetative growth parameters significance differences were observed between the mango (*Mangifera indica* L.) varieties. Higher survival rate was recorded from Keitt variety followed by Kent and Tommy Atkins varieties. In terms of tree height, Kent mango variety exhibited maximum tree height (4.693m) and the lowest tree height (2.65m) was obtained from Keitt mango variety. Based on their canopy spread, Tommy Atkins and Kent mango varieties were observed to have larger canopy spread. However, from Keitt and Tommy Atkins mango varieties minimum canopy spread was recorded.

Regarding yield and yield components, significance differences were observed between mango varieties. The maximum fruit length 13.87 cm was recorded from Keitt

mango variety. Whereas, in terms of fruit length a significance differences were not observed between Kent, Tommy Atkins and Apple mango varieties. The highest fruit width of 10.567 cm and 9.767 cm were recorded from keitt and Apple mango varieties respectively. Moreover, the findings of this study showed that the maximum 614.1gm fruit weight was found in Keitt mango variety.

As the finding of this study showed that, the recorded number of fruits per tree of the mango varieties was varied statistically. Kent mango (*Mangifera indica* L.) variety was produced higher number of fruits per tree followed by Apple mango variety. On the other hand, from Keitt and Tommy Atkins mango varieties minimum number of fruits per tree was recorded. With regard to fruit yield per tree the maximum was found in Kent variety (7.943 kg/tree) followed by Apple mango variety (6.173 kg/tree). While, the lowest yield per tree 2.093 kg and 4.320 kg were recorded from Keitt and Tommy Atkins mango varieties respectively.

In this study, the maximum fruit yields/ plot performances were recorded from Kent (47.9kg/plot) and Keitt mango variety (47.41 Kg/plot). While, the minimum 27.92 Kg/plot yield was obtained from Tommy Atkins variety followed by Keitt variety (12.72kg/plot). In terms of total fruit yields per hectare, the maximum yields were obtained from Kent (7983kg/ha) and Apple mango (7901kg/plot). While, the minimum yields per hectare were recorded from Tommy Atkins (4320kg/plot) and Keitt mango variety (2120 kg/plot). Therefore, based on their yield performance Kent and Apple mango varieties were recommended for Adola Rede District and similar agro-ecologies. Furthermore, for mango disease control additional studies could be conducted and given emphasis for future works.

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