



Original Paper

Evaluation of Improved Hermaphrodite Papaya (*Carica papaya* L.) Varieties for Growth, Yield and Quality at Teppi, Southwestern EthiopiaShamil Alo Sora^{1*}, Merga Jibat Guji¹

1) Ethiopian Institute of Agricultural Research, Tepi Agricultural Research Center, Po. Box. 34.

*) Corresponding Author: shamilalo99@gmail.com

Received: 15 May 2024; Revised: 04 June 2024; Accepted: 28 June 2024

DOI: <https://doi.org/10.46676/ij-fanres.v5i2.237>

Abstract— The fruit with the most commercial significance in the Caricaceae family is the papaya (*Carica papaya* L.). The fruits are very valuable in terms of nutrition, economy, and medicine. One of the things restricting its production and productivity in Ethiopia is the lack of improved cultivars. In order to determine the optimum high yielding, pest and disease tolerant, variety/ies for the target area, this study was carried out to evaluate the performance of improved papaya varieties. Three newly released papaya varieties were brought to Teppi agricultural research center from Melkassa agricultural research center for evaluation over the cropping seasons of 2019/20 to 2020/21. The experiment was laid out in randomized complete block design and replicated three times. The mean yield was ranged from 34.24 to 90.08 t/ha for Braz-HS1 and Meki-HL1 varieties respectively. The findings of the study revealed that, based on the recorded parameters Meki-HL1 variety performed better followed by Koka-HM1 variety and these two varieties will be recommended for the surrounding farmers for wider production. Further study should be carried out with improved varieties to improve papaya production and nutritional security as well, especially in southwestern Ethiopia.

Keywords— Hermaphrodite, nutrition, physical quality, released varieties

I. INTRODUCTION

The papaya (*Carica papaya* L.), a member of the Caricaceae family and a fruit that is widely consumed in many tropical nations, is a significant fruit crop. The fruits are rich in calories, protein, fat, carbohydrates, calcium, iron, sodium, potassium, carotene, vitamin B2, niacin, and vitamin C.). Besides that, it is a source of flavonoids, carotenoids, vitamins, and antioxidants [9]. The top five papaya-producing nations in the world are Mexico (836,370 tons), Nigeria (850,000 tons), Indonesia (840,121 tons), Brazil (1.6 million tons), and India (5.6 million tons). Papaya is one of the common fruits grown in Ethiopia and its farming in Ethiopia involved over 921,066 small-scale farmers [2]. Papaya production in Ethiopia is 72,007.768 tons on 5,096.09 ha of land, and its productivity is 14.13 ton which is extremely low when compared to global production average [2]. Even if the production trend is expanding over time, Ethiopia has not paid enough attention to this valuable fruit that

might bring economic profits from the export market as compared to top papaya producer countries. As a result production and export is very low due to various abiotic and biotic factors [5]. The lack of improved papaya variety in Ethiopia was one of the factors causing the low productivity of the fruit [8]. Due to the fact that agroecology plays a significant role in papaya production, Ethiopia has the potential to industrialize the production process and rank among the top papaya-producing and exporting countries in the world.

Growers are currently obliged to use unknown open pollinated varieties and segregating generations due to the absence of improved and uniform dioecious papaya varieties in the country. This results in a decrease in subsequent growth, yield, and yield component performance [12]. Currently, three hermaphrodite papaya varieties namely, Braz-HS1 Koka-HM1 and Meki-HL1 were nationally released in Ethiopia by Melkassa Agricultural Research Center for fresh consumption [10]. Hence, the aim of the present study was to evaluate the performance of different released papaya varieties and recommend the best performed variety for wider production for the target area.

II. MATERIALS AND METHODS

A. Study Area

The field experiment was conducted from 2019/20 up to 2020/21 at Teppi Agricultural Research Centre, in south western Ethiopia. Teppi is located at an elevation of 1,200 m above sea level. The research centre receives an annual rain fall of 1,678 mm with average maximum and minimum temperature of 30 0C and 16 0C, respectively Table 1). The soil of the experimental site is redish brown sandy clay loam classified as Nitosol with pH varying from 5.6 to 6.

B. Experimental materials and design

The experiment was based on three released papaya varieties which were obtained from Melkassa Agricultural Research center. Randomized complete block design with three replications was used to conduct the experiment. Papaya seeds were sown in polyethylene bag on the nursery site. The experimental field was cleaned and ploughed by using tractor.

Then after, planting hole was prepared two months prior to planting. The seedlings were transplanted to main field after two months when they have laid four true leaves at 2m * 2m spacing between rows and between plants respectively. Cultivation and weed management and all other important agronomic practices were done as per the recommendation for papaya production.

C. Data Collection and Analysis

From the planting date through the harvest time, several parameters were recorded. The following is a list of the key

parameters gathered: Plant height (cm), Stem Girth (cm), Leaf Number, Internode Length (cm), Fruit Number, total fruit weight per plant, yield in ton/ha, Quality Parameters like: Shape of central cavity, Fruit shape, Smoothness, Fruit color, Flesh color, Fruit length (cm), Fruit diameter (cm) were collected and the collected data was analyzed using R software. During data collection fruit weight per plant was collected at each harvest and the summation was used. Fruit length and diameter were collected at each harvest and the average values were used.

TABLE 1. SUMMARY OF WEATHER AND SOIL INFORMATION

Location	Altitude (masl)	Rainfall (mm)	Latitude	Longitude	Temperature		Soil information			
					Max	Min	N (%)	P (ppm)	OC (%)	OM (%)
Teppi	1200	1678	7° 3'	35° 18'	30 °C	16 °C	0.706	11.96	5.06	8.70

III. RESULTS AND DISCUSSION

The analysis of variance showed significant differences due to varieties and years for most of the characters tested. The over years combined analyses of variance revealed that there was significant difference ($P < 0.05$) among varieties for all parameters considered in the study (Table 2, 3 and 4).

A. Growth Parameter

When compared to the others, the variety Meki-HL1 had the tallest plant height (182.79cm), while variety Braz-HS1 was shorter (131cm). [8] noted the variation in variety-specific plant height. The stem girth size for these varieties ranged from 22.22 cm for Koka-HM1 to 21.63 cm for Braz-HS1 (Table 2). The

difference in the plant girth could be probably due to the genetic variation among the cultivars. This result is line with findings of [8] that reported variation in stem girth ranging between different papaya varieties. The number of functional leaves per plant varied between 18.75 and 22.17 for Koka-HM1 and Braz-HS1 respectively (Table 2). In the present study, the cultivars with vigor stem girth size had comparable leaf number with shorter cultivars. Different papaya varieties had a considerable difference on the phonological parameters. The results of the analysis of variance revealed that all cultivars had statistically non-significant values for the parameters mean stem girth and leaf number. The findings are consistent with those of [8] and [4], who discovered variations between different papaya varieties.

TABLE II. MEAN GROWTH PERFORMANCE OF RECENTLY RELEASED HERMAPHRODITE PAPAYA VARIETIES

No	Varieties	Plant height (cm)	Stem Girth (cm)	Leaf Number	Internode Length (cm)
1	Meki-HL1	182.79 ^a	21.89 ^a	21.61 ^a	6.69 ^b
2	Koka-HM1	155.63 ^b	22.22 ^a	18.75 ^a	8.94 ^a
3	Braz-HS1	131 ^c	21.63 ^a	22.17 ^a	7.17 ^{ab}
P-value		<.0001	0.98	0.4030	0.0601
LSD		5.35	7.99	5.78	1.92
CV		2.65	28.34	21.58	19.67

B. Yield Parameter

When During first year the highest yield were gained for Meki-HL1 (89.23t/ha) followed by Koka-HM1 (66.72); and the least yield were for Braz-HS1 (28.91) (Table 3). Generally, yield during first year was low as compared to that of second year. This might be as a result of the papaya only exhibiting vegetative development for the first eight to ten months after planting, before it began to bear fruits. The highest yields in second year was attained by Meki-HL1 (90.93 tons) and followed by Koka-HM1 (65.01 tons). The combined analysis of the two year data revealed that, the highest and lowest fruit yields were 90.08 and 34.24 tons for Meki-HL1 and Braz-HS1 respectively. Analysis of variance showed that papaya varieties were significantly different for fruit weight throughout two years (Table 3). From

the combined analysis of the two year data, Papaya variety with largest average fruit weight was Meki-HL1 (819.3grams) followed by Koka-HM1 (469.3grams). This indicate that, the different papaya varieties vary in their fruit size. [8], also reported varying average fruit weight of papaya varieties which is in line with the result reported in this study. The fruit weight per plant varied between 21.4 and 56.3 Kg/plant on average. The average fruit length was ranged from 11.27 cm for the variety Braz-HS1 to 19.3 cm for the variety Meki-HL1. The current study's findings revealed that the average fruit diameter ranged from 8.2 cm for the variety Braz-HS1 to 9.89 cm for the variety Meki-HL1 (Table 4). [8] and [4], also reported varying fruit lengths and diameter, which were in similar ranges with the finding of the present study.

TABLE III. YIELD PERFORMANCE AND AVERAGE FRUIT WEIGHT OF PAPAYA VARIETIES

No	Varieties	Total yield (t/ha)			Average fruit weight (gram)		
		Year 1	Year 2	Combined	Year 1	Year 2	Combined
1	Meki-HL1	89.23 ^a	90.93 ^a	90.08 ^a	826.67 ^a	812.0 ^a	819.3 ^a
2	Koka-HM1	66.72 ^a	65.01 ^b	65.87 ^b	476.67 ^b	462.0 ^b	469.3 ^b
3	Braz-HS1	28.91 ^b	39.57 ^c	34.24 ^c	358.33 ^c	343.7 ^c	351.0 ^c
P-value		0.0067	0.0012	<.0001	<0.0001	<0.0001	<.0001
LSD		25.28	16.63	10.906	149.4	5.76	0
CV		18.1	10.64	11.57	7.99	7.04	1.939

TABLE IV. PERFORMANCE OF SELECTED PAPAYA VARIETIES WITH REGARD TO FRUIT NUMBER, WEIGHT, FRUIT LENGTH AND FRUIT DIAMETER

No	Variety	Fruit Number	Total fruit weight Kg/plant	Fruit length (cm)	Fruit diameter (cm)
1	Meki-HL1	67.33 ^a	56.3 ^a	19.3 ^a	9.89 ^a
2	Koka-HM1	66.33 ^a	41.17 ^b	13.746 ^b	9.09 ^b
3	Braz-HS1	38 ^b	21.4 ^b	11.27 ^b	8.2 ^c
P-value		0.0017	<.0001	0.0001	0.0024
LSD		11.283	6.81	2.5924	0.7781
CV		13.62	11.57	13.64	6.67

TABLE V. PERFORMANCE OF SELECTED PAPAYA VARIETIES WITH REGARD TO QUALITATIVE PARAMETERS

No.	Variety	Shape of central cavity	Fruit shape	Smoothness	Fruit color	Flesh color
1	Meki-HL1	pear	pear	rough	yellowish	Bright yellow
2	Koka-HM1	pear	pear	intermediate	yellowish green	Reddish orange
3	Braz-HS1	oval	pear	intermediate	yellow	Reddish orange

C. QualityParameter

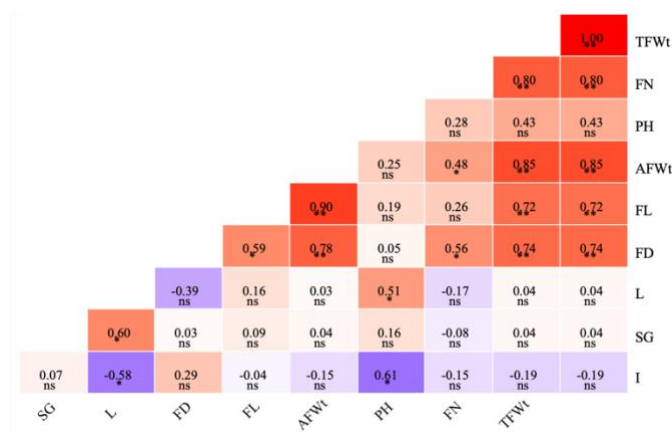
In addition to yield and other vegetative parameters, quality attributes had also taken into account during the study. Based on information presented in Table 5, all varieties performed well for several parameters among quality parameters considered. All tested varieties were with low amount of fiber content in their flesh parts. All varieties had low to medium ridging of fruit surface. Other quality parameters such as shape of central cavity, fruit shape, smoothness, fruit color and flesh color had also recorded.

D. Correlation analysis

The correlation coefficients between growth parameters and yield components are displayed in figure 1 below. Yield had a highly significant positive association (0.74) with fruit diameter, (0.72) with fruit length, (0.85) with average fruit weight, (0.8) with fruit number, (1.00) with total fruit weight. A significant correlation between the average fruit weight and the fruit diameter was observed (0.78). Average fruit weight and fruit length showed a strong positive association (0.90).

This finding is consistent with those of [3], [7] and [13]), who reported significant positive association between different traits on several papaya cultivars. They reported that there were

positive correlation between fruit yield per plant, total fruit yield, number of fruit per plant, average fruit weight, fruit diameter, fruit length and number of fruit yield per plant. [6] also reported similar results.



SG= stem girth, LN= leaf number, FD= fruit diameter, FL=fruit length, AFWt =average fruit weight, PH=plant height, FN= fruit number, TFWt= total fruit weight, tha= total yield in ton/ha

Fig. 1. Phenotypic correlations between growth parameters and yield components of papaya varieties

IV. CONCLUSIONS

Three released hermaphrodite papaya varieties were tasted at Tepi Agricultural Research Center in randomized complete block design with three replications for two years. Among these varieties, the best performing varieties like Meki-HL1 and Koka-HM1 were selected for the target area and areas with similar agro-ecologies. The cultivars like Meki-HL1 and Koka-HM1 ought to be multiplied and spread throughout the region. To increase papaya yield and productivity, papaya cultivars with high yields, excellent quality, and strong disease resistance must be released and popularized. In addition to variety enhancement, crop pre- and post-harvest handling should be given priority. To increase papaya yield and productivity, papaya cultivars with high yields, excellent quality, and strong disease resistance must be released and popularized. In addition to variety enhancement, crop pre- and post-harvest handling and disease should be given priority.

ACKNOWLEDGMENTS

I would like to acknowledge the financial support provided by Ethiopian Institute of Agricultural Research and Tepi agricultural research center. I highly appreciate and acknowledge the effort made by respective researchers, field assistants for their unreserved support and substantial contribution to accomplish this study.

REFERENCES

- [1] Central Statistical Agency Agricultural Sample Survey. (2018). The federal democratic republic of Ethiopia, Meher Season (2017/2018).
- [2] CSA (Central Static Agency). (2020/21). Agricultural Sample Survey Report on Area and Production of Major Crops. Volume I. The Federal Democratic Republic of Ethiopia, Addis Ababa, Ethiopia. Statistical Bulletin 590.
- [3] Da Silva, F. F., Pereira, M. G., Ramos, H. C. C., Junior, P. C. D., Pereira, T. N. S., Gabriel, A. P. C., Viana, A. P. and Ferreguetti, G. A. (2007). Selection and estimation of the genetic gain in segregating generations of papaya. *Crop Breed. Appl. Biotechnol.* 8 (1): pp: 1-8.
- [4] Fikre, G. and Mensa, A. (2021). Evaluation of improved hermaphrodite papaya (*Carica papaya* L.) varieties at Arba Minch, Southern Ethiopia. *Int. J. Agril. Res. Innov. Tech.* 11(2): 69-71. <https://doi.org/10.3329/ijar.v11i2.57257>.
- [5] Gabrekiristos E, Dagnew A. (2020). A Newly Emerging Disease of Papaya in Ethiopia: Black Spot (*Asperisporium caricae*) Disease and Management Options. *J Plant Pathol Microbiol* 11: 488. doi: 10.35248/2157-7471.20.11.488
- [6] Jambhale, V. M., Kute, N. S. and Pawar, S. V. (2014). Studies on genetic variability parameters, trait association and path analysis among yield and yield contributing traits in papaya *carica papaya* (L.) the bioscan. 9 (4): pp: 1711-1715.
- [7] Kumar, M., Prasad, K. M., Prakash, S. and Kumar, S. (2015). Evaluation of Genetic Variability, Genetic advance, Heritability and Character association for Yield and its Contributing traits in Papaya (*Carica papaya* L.). *VEGETOS*. Vol. 28 (2): pp: 99-102
- [8] Lemma Ayele, Edossa Etissa, Asmare Dagnew, Wagayehu Assefa, Girma Kebede, Mekasha Girma, Kidist Firde, and Merkedu Ayalew. (2017). Development of Hermaphrodite Papaya (*Carica papaya* L.) Varieties for Production in Ethiopia. *Academic Research Journal of Agricultural Science and Research*, Vol. 5(7), pp. 561-569, DOI: 10.14662/ARJASR2017.087
- [9] Maisarah, N. A., Asmah, B. R. and Fauziah, O. (2013). Antioxidant analysis of different parts of *Carica papaya* ‘International Food Research Journal’ 20(3): 1043-1048.
- [10] MoARD (Ministry of Agriculture and Rural Development). (2016). National crop Variety Registry Issue.18: 280-300.
- [11] Shantamma SG, Rangaswamy KT, Bheemanagouda H.P. (2014). Management of black spot of papaya caused by *Asperisporium caricae*. *International Journal of Plant Protection*.;7:212-216.
- [12] Wegayehu Assefa, Lemma Ayele, Asmare Dagnew, Edossa Etissa, Girma Kebede Mikiyas Damtew, Merkebu Ayalew. (2016). “Variability, Association and Path Coefficient Analysis of Yield and Yield Components of Dioecious Papaya Genotypes in Ethiopia. *International Journal of Research in Agriculture and Forestry* Vol. 3 (10), PP 8-14 ISSN 2394-5907 (Print) & ISSN 2394-5915 (Online).
- [13] Wegayehu Assefa, Lemma Ayele, Asmare Dagnew, Edossa Etissa, Girma Kebede Mikiyas Damtew, Merkebu Ayalew. (2016). Variability, Association and Path Coefficient Analysis of Yield and Yield Components of Dioecious Papaya Genotypes in Ethiopia. *International Journal of Research in Agriculture and Forestry* Vol. 3 (10): PP: 8-14.