RESEARCH PROGRAM ON Forests, Trees and Agroforestry

CGIAR

Clonal and Seasonal variation in fruit yield of *Uapaca kirkiana* in Malawi

By
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Abstract: *Uapaca kirkiana* or wild loquat is an important indigenous tree species of the Miombo woodlands with a huge potential to improve the nutrition and livelihoods of millions of smallholder farm families in southern Africa. Domestication of wild loquat was identified as key to enhance fruit production and reduce reliance on the forests. As part of the domestication process, grafted trees from superior phenotypic trees were used to establish a clonal test at Makoka research station (altitude 1029m asl; latitude 15˚32'S; longitude 35˚11'E) with the objective of identifying superior clones for on-farm cultivation. The trial comprised 30 clones each with between one and 19 ramets. Growth and fruit yield data was collected over a period of 5 seasons to determine fruit yield potential of the clones. Based on this limited scale testing, clones MW48 and MW26 were identified as having high yield potential and could be promoted for planting in the interim as there is currently no material of known performance available. Other clones (MW22, MW80, MW50) which showed exceptionally high fruit yield potential (up to 100kg per tree) require urgent testing as they were inadequately tested in the present study. Although grafted *U. kirkiana* trees fruit at about 4 years, they appear to take more than 14 years to reach maximum production.

Fig. 1: Heavy fruit loaded tree in the wild, Dedza, Malawi

Introduction: *Uapaca kirkiana* (Muell. Arg.) is an important indigenous fruit tree species of the Miombo woodlands in southern Africa. The species was identified as a priority species for domestication two decades ago (Kadzere *et al*., 1998). The species' natural range of distribution spans eastern Angola, southern DRC, Burundi, Tanzania, Zambia, Malawi, Mozambique to Zimbabwe (Fig. 2). The altitudinal range of spans from 500m a.s.l. to 2000 m a.s.l. across a unimodal rainfall region receiving 500–1400 mm per annum (Ngulube *et al*., 1998). This large latitudinal and altitudinal range and rainfall is likely to have created a wide genetic variation in the species that could be exploited through selection and breeding.

Wild loquat fruits are primarily consumed as a fresh fruit. Different communities also process wild loquat fruits differently to produce a wide range of products such as juice or squashes, jam, wine, sweet beer, porridge and cakes. The fruit is widely sold on roadsides in rural areas and informal urban markets (Ramadhani, 2002). Currently, fruits are collected from wild stands in forest areas as well as trees deliberately retained on crop fields. Household income from sale of wild loquat fruit ranges from US$10 to US$260 with an average of US$67 (Chadzimura, 2016) per harvesting season, a sizeable amount considering the low investment. This yearly income is enough to buy up to five, 50kg bags (0.25 tonnes) of the staple food (maize) reducing the hunger gap which falls within the fruiting season.

Clonal testing was identified as a key part of a rapid process of developing superior cultivars of wild loquat (Akinnifesi *et al*., 2006) as trees raised from seedlings take more than 10 years to start fruiting and may take more years to reach maximum production. The primary objective of the study was to determine the growth and fruit yield potential of wild loquat clones identified through participatory selection with farmers.

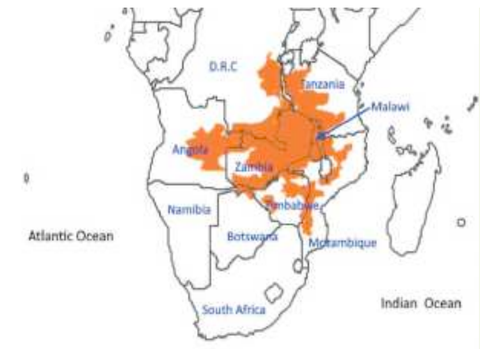

Fig. 2: Natural range of distribution of Uapaca kirkiana

Materials and Methods: Thirty phenotypic superior trees in fruit attributes (fruit yield, fruit size and sweetness) were identified and selected in central and southern Malawi. Fruits were collected from the 30 superior trees in November 2002. Seed was extracted from the fruits and was immediately sown to raise seedlings as per recommended practice (Ngulube *et al*., 1996; Mhango *et al*., 2008). Once the seedlings had reached size for grafting, scions were collected from the same selected trees and grafted on the corresponding seedling stocks to minimise chances of grafting incompatibility and intraclonal variability.

A total of 152 plantable ramets from 30 clones were available for the clonal test. They were between one and 19 ramets per clone. A field trial was established with the grafted trees in April 2005 at Makoka Research Station (altitude 1030m a.s.l.; latitude 15˚30'S; longitude 35˚15'E; Rainfall 1020mm). The soil is sandy loam of type Oxic Haplustalf. The field design was a completely randomised with varying plot sizes of 1 to 13 trees. Trees were spaced 4x2m at establishment.

Data collected include growth traits (tree height, Crown Depth, Crown diameter) at 9, 11 and 14 years while fruit yield traits (yield, number of fruits, weight of individual fruit) were assessed annually from 9 years to 14 years. Data was analysed using GLM procedure in SAS on individual tree data. Data on growth traits was analysed for individual years while that of fruit yield was analysed across the five years at ages 9, 10, 11, 12 and 14 years to investigate potential year by clone interaction.

Fig. 3: Grafted wild loquat tree fruiting and showing reduced tree size

Results and Discussion: Differences between clones for all the growth (height) and crown size (crown depth, crown diameter) and fruit traits were all significant at varying probability levels. There was large variation in height and crown size (depth and diameter) and fruit traits (yield, fruit size and no. of fruits) among the 30 clones tested (Table 1). At 14 years, five clones produced 3,000 or more fruits (Fig. 4). In wild stands, Chirwa *et al*., (2007) reported yields of up to 2000 fruits although the age of the trees was not given. Over the three assessments (11, 12 and 14years) when all clones fruited, 58% of the clones showed a progressive increase in the number of fruits indicating that they had not reached maximum production. The five most productive clones in terms of fruit yield and number of fruits are MW22, MW80, MW50, MW48 and MW26 based on 14-year fruit yield data. However, three of these clones (MW22, MW80, MW50) were not adequately tested as they had le ss than 4 ramets per clone available. The largest fruits were from clones MW30, MW10, MW11, MW3, MW7 and MW86 (Fig. 5) which exceed the sizes reported in natural stands (Ngulube et al., 1997) but comparable to those reported by Mng'omba et al. (2015).

Table 1: Least squares mean ranges for growth, crown size and fruit traits

Range	Tree height (m)			Crown Diameter (m)			Crown Depth (m)			Number of fruits at:					Weight of fruits in kg at:				
	Ht14	**Ht11**	**Ht9**	**CD14**	**CD11**	**CD9**	**CDepth14**	**CDepth11**	**CDepth9**	14yrs	12yrs	11yrs	10yrs	9yrs	14yrs	12-yrs	11-yrs	10yrs	9yrs
From	6.3	4.4	2.1	3.6	1.6	1.7	4.9	3.1	0.40	124	74	154	0	0	4.3	1.3	2.4	0.0	0.0
To	13.0	11.5	7.7	6.3	4.1	4.3	11.5	10.2	1.60	5277	1522	3202	531	292	100.2	30.8	53.3	12.6	37.4

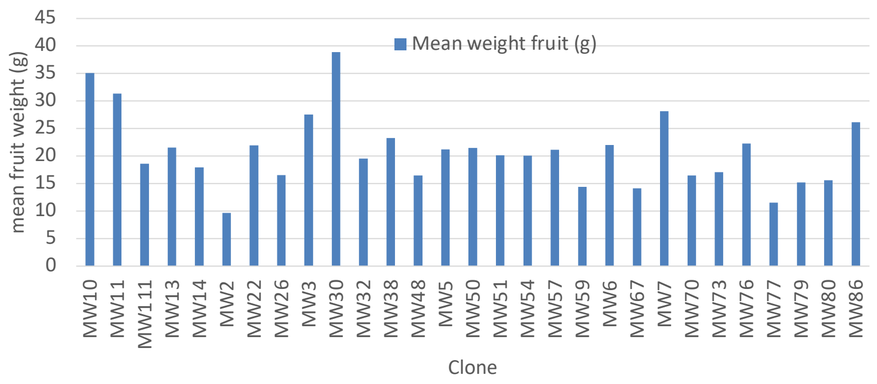

Fig 4. Mean fruit weight (grammes) of 30 clones at Makoka

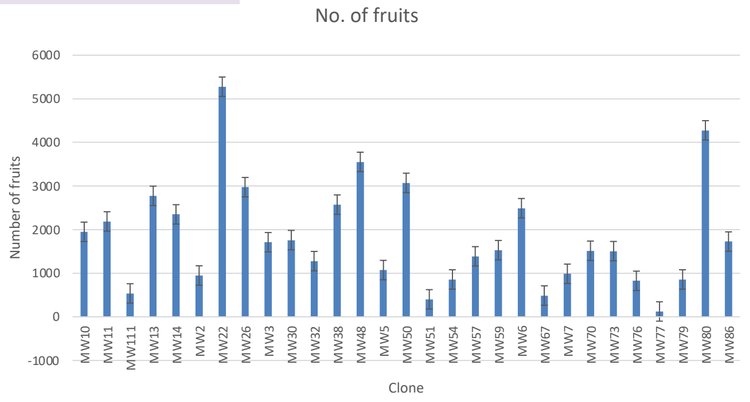

Fig. 4. Least Square Mean Number of fruits per tree at 14 years

Results and Discussion (cont'd): Correlations between growth, crown size and fruit traits were also computed for 12 and 14-year traits when all clones were in fruit (Table 2). Some of the correlations although significant were mostly small (r<0.20) and are of limited value. For example, correlations between canopy size (canopy depth and canopy diameter) and fruit traits (number of fruits or total yield) were nonsignificant although Jenya *et al*., (2015) reported moderate but significant correlations. Age-age (12-14years) correlations of either growth traits or crown size traits were significant, large and positive while those for fruit traits, although significant were weak to moderate. For example, the correlation between 12-year and 14-year fruit yield of 0.37 was highly significant (P>0.0001) but its utility is likely to be limited.

Table 2: Pearson's correlation coefficients among 12- and 14-year growth and fruit traits

	Fruit size 12yrs	Height 12yrs	Crown diameter 12yrs	Crown depth 12yrs	No. of Fruits 12yrs	Fruit Yield 12yrs	Fruit size 14yrs	Height 14yrs	Crown diameter 14yrs	Crown depth 14yrs	No. of Fruits 14yrs	Fruit Yield 14yrs
Fruit size -12yrs	1.00	0.11^{ns}	0.03 ^{ns}	0.10ns	0.49***	0.49***	0.67***	0.11^{ns}	0.01^{ns}	0.05^{ns}	0.38***	0.37***
Height -12yrs		1.00	0.17^{ns}	1.00*	0.18*	0.17^{ns}	0.20*	0.89***	0.10^{ns}	0.90***	0.12^{ns}	0.03^{ns}
Crown diameter -12yrs			1.00	0.17^{ns}	0.06 ^{ns}	0.04^{ns}	0.03^{ns}	0.14^{ns}	0.86***	0.14^{ns}	-0.01^{ns}	-0.07^{ns}
Crown depth -12yrs				1.00	0.18*	0.16^{ns}	0.19*	0.89***	0.10^{ns}	0.89**	0.11^{ns}	0.03^{ns}
No. of Fruits -12yrs					1.00	0.96***	0.45***	0.09^{ns}	0.04^{ns}	0.17^{ns}	0.40***	0.33***
Fruit Yield -12yrs						1.00	0.44***	0.08^{ns}	0.01^{ns}	0.16^{ns}	0.38***	0.37***
Fruit size -14yrs							1.00	0.14^{ns}	-0.04^{ns}	0.14^{ns}	0.43***	0.37***
Height -14yrs								1.00	0.09^{ns}	0.80***	0.15^{ns}	0.08^{ns}
Crown diameter -14yrs									1.00	0.05^{ns}	0.03^{ns}	-0.03^{ns}
Crown depth -14yrs										1.00	0.03 ^{ns}	-0.02 ^{ns}
No. of Fruits -14yrs											1.00	0.87***
Fruit Yield 14yrs												1.00

^{ns}, *, **, *** for not significant at 5% and significant at 5%, 1% and 0.1% respectively

Conclusions: Six clones produced significantly larger fruits compared to the sizes recorded in natural stands. This demonstrates a significant improvement in fruit size from selection.

- Some clones (MW48 and MW26) showed high yield potential and therefore could be recommended for limited scale planting in Malawi in places were unknown material is being planted.
- Clones (MW22, MW80, MW50) showed a high fruit yield potential (up to 100kg) but were inadequately tested as they had less than four ramets.
- Although grafted *Uapaca kirkiana* trees fruit at about 4 years, they take more than 14 years to reach maximum production which is similar to Macadamia
- Over a period when all clones were fruiting, more than 58% of the clones showed a progressive increase in fruit yield between 11 and 14 years. For the few that showed a decline in between these years, it was not apparent whether this could be attributed to climate and mild form of mast fruiting

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