Performance of local variety mango graft unions under nursery conditions

Research · June 2015

DOI: 10.13140/RG.2.1.4404.8485

1 author:

James Ajal
Swedish University of Agricultural Sciences
8 PUBLICATIONS **65** CITATIONS

SEE PROFILE

Performance of local variety mango graft unions under nursery conditions

J.Ajal[1] and Elizabeth. B. Kizito*

Department of Agricultural and Biological Sciences, Uganda Christian University

Key words: mango, graft wound healing, local varieties, nursery

Abstract

The performance and graft wound healing in *Mangifera indica* (local varieties) under nursery conditions has not been taken with great keen despite its role in raising a viable orchard. The objective of this study was to assess graft establishment and success of different local variety mango scions on local rootstocks using splice grafting as a method of propagation. Scion lengths were measured and data on number of leaves, time of bud sprouting and leaf size were subjected to analysis. The analysis revealed that graft union healing and establishment of the local mangoes vary according to the cultivar used. Kate variety registered the highest level of survival of 70 %. There were also differences in the time of bud sprouting of the three varieties. The difference in bud sprouting and graft survival was due to different levels of rootstock-scion compatibility which have implications in wound healing. Studies on improving compatibility levels is needed to increase graft success at nursery level.

Introduction

The mango (*Mangifera indica*), is claimed to be one of the most important fruit of the tropics ranked second to bananas. This is attributed to its attractive appearance and the very pleasant taste of selected cultivars. It has been referred to as 'king of all fruits' (Purseglov, 1972). Worldwide mango cultivation now covers approximately 2.9 million hectares (FAO, 2001).Uganda mainly obtains its peak harvests of mangoes in the April season. According to a study by IITA, mango purchases in urban and peri-urban Kampala area is about 250kg/day at a minimum (FIT report, 2007).

Mangoes have been known to grow wildly, with different varieties grown in almost all the districts. Traditionally many rural and peri urban homesteads in Uganda have at least a mango tree scattered on the farm. The commonly grown varieties are the local varieties which yield small fruits and trees that grow tall and are usually left to grow naturally without much crop husbandry. Commercial farms of mangoes have been encouraged through crop improvement strategies and the introduction of improved varieties in the country.

Over thirty improved local and exotic mango cultivars are currently being grown on

[1] James Ajal, Msc Plant Science student
Wageningen University
James.ajal@wur.nl

* Student Academic Supervisor
Department of Agricultural and Biological Sciences
Uganda Christian University

subsistence and commercial scale throughout the country. Improved local varieties include; Ddodo, Bire, Sejjembe, Naruzale. Exotic varieties include; Zillate, Pulvin, Tommy Atkins, Boribo, Glen, Kent, Keitt, Apple mango. The introduction of improved varieties have been welcomed especially after adaptive research by the Zonal Agricultural Research and Development Institute (ZARDIs) with stations scattered in almost all regions of the country. These improved mango varieties have monoembryonic seeds which,when planted, do not reproduce true to type.

There exists a great scope to grow grafted elite varieties in the homestead areas as well as in orchard to increase the production. The vegetative method is desirable because it enables to retain the characteristics of the mother plant, to get flower and fruit earlier, to remain initially relatively smaller with the benefit of more plants accommodation per unit area and to give the owners earlier and much higher economic returns. The improved varieties have in turn been used to improve the local varieties to dwarf, reduce maturity time and produce bigger fruits through grafting. Grafting refers to various techniques of inserting a section of the stem with leaf buds (the scion) into the stock. Since dormant scions are used, grafting is normally done before growth begins. It is the most preferred method for improving and propagating local mango varieties (Simon et al, 2010). Almost all methods of grafting can be adopted for mangoes but two popular methods used are cleft graft and whip-and-tongue graft however this research will mainly focus on splice grafting.

In spite of these improved methods, farmers have continued to obtain high yield losses from graft failures especially at the nursery level while using the above methods. Graft failure is caused by a number of factors. These are: the choice of scion wood, light intensity, alignment of cambia of stock and scion, time of grafting, temperature under which grafts are grown and scion desiccation after grafting (Barnet and Kindle, 2000). Normally, grafting does not register 100% success due to yield loss however, the choice of scion wood, and the alignment of cambia of stock and scion contribute the largest percentage of grafting success (Crasweller, 2005).Anatomical studies have shown that the difficulty in grafting may be due to a marked difference in cellular activity between stock and scion, manifested as a delay in or failure of stock and scion to produce wound parenchyma, especially in the scion (Gyambo, 2000).

In the recent years, simple methods of propagation like grafting have not yielded satisfactory results at village/farmers level either due to poor grafting methods, lack of skills and knowledge, provision of required conditions or varieties used. Although substantive research since the 1970s has been done by NARO/FORRI on mango cultivars which are high yielding and suited to the various agro-ecological zones, there is still a gap that needs to be addressed. The main challenge now is based on individual performance of the different local varieties to grafting. The effect of different scion-rootstock combinations on graft wound healing is not known.

Because of this, many grafts have failed at the nursery stage partly because farmers are unaware of the cultivar compatibility of scions and local rootstocks. Most of which are obtained locally irrespective of their genetic and phenotypic characteristic. The objective of this study was to assess graft establishment and success of different local variety mango scions on local rootstocks using splice grafting as a method of propagation. It was hypothesised that varietal difference of the cultivars does not affect the rate of graft wound healing and establishment on selected local mango varieties

Materials and methods

Experimental site

The experiment was set up under nursery conditions in a screen house at Loyal Plants, a commercial tree nursery located in the Lakeshore Forest Management Zone according to the National Forestry Authority zoning.

Three improved local varieties were grafted on local mango rootstocks and left to establish for four weeks with good and recommended nursery practices. The local rootstocks were sourced from one of the prominent model farmers in the area who managed them with recommended practices up to about 6 months from planting, a good stage for grafting to be done. The rootstocks used in the experiment were actively growing seedlings from seeds collected from mature and disease free mangoes from the previous season. Local varieties are normally preferred as rootstocks because of their resistance to diseases and adaptability to local environmental condition

The local varieties used as scions were; Kate, Ssu/Lubere and Bire. The scions were obtained from the mango mother garden at Mukono Zonal Agricultural Research and Development Institute (MUZARDI), which have mangoes that are healthy, well managed and free from common diseases. Only scions with swollen buds ready to sprout were collected from the selected variety mother plants. This was done on the same day of grafting and then later wrapped in a polythene bag to reduce desiccation.

Due to the efficiency and greater cambial contact provided by splice grafting method, it was used in the experiment. The three different local mango scions were grafted with "Kagogwa" rootstocks using the above method. The rootstock were cut off about 20 cm above the soil line in the pots and then sliced at the centre of the stem for subsequent insertion of the scion. The basal end of the scions were trimmed by making slanting cuts on one side using a sharp grafting knife. Then, the same slanting cuts were made on the rootstocks and bound together so that the cambial layers of both the scion and rootstock are firmly attached to each other to minimize water loss and encourage union formation.

The graft unions were then wrapped using grafting tape, and covered with a thin transparent polyethylene bag (30 micron size) to ensure high relative humidity. Polyethylene bags were later removed as soon as the buds sprouted and new leaves begun to form. The grafted mangoes were placed in a screen house that allows 75% solar light and temperature to penetrate through. This was aimed at providing optimum humidity required for union healing and general graft establishment.
The experiment was designed as below with humidity, light, temperature and other environmental factors uniform in the set up. The main variable was the variety of the mangoes used.

A completely randomized block design was used in the experiment in order to reduce errors obtained as a result of location and environmental variation. Three different blocks were established for each lot of rootstocks to be grafted with the same variety scions. The set up was replicated three times for consistence and valid data. In total, 9 blocks were established with a total of 90 seedlings i.e. 10 seedlings per block. Thereafter, the set up was managed using recommended nursery techniques for four weeks with daily watering except for days that the area received rainfall. Observations and data were collected as the leaves and buds begun to sprout. Data was collected from each setup considering the healing rate and after the experiment, the percentage based on performance over the overall set was obtained using the formula;

$$\%\ \text{survival} = \frac{succesful\ grafts}{Total\ grafted\ plants} \times 100$$

Data collection

Data collection was done on a weekly basis, taken from all the blocks in the design. The data collected include; time of first bud appearance, number of sprouting buds at a given time, size and number of sprouting leaves, scion length and number of successful grafts at the end of the experiment. The effects of the above treatments on the three local mango varieties were then compared.

Data Processing and analysis

The data obtained from the experiment were analyzed in Microsoft Office Excel 2007 and PAST (Paleontological Statistics) Software through a single factor analysis of variance (ANOVA). ANOVA was used because it maximizes the degrees of freedom of the residuals (errors) by detecting smaller differences between treatments. All tests were done at 5 % level of significance
The sources of variation within the trial were used to determine whether or not they are statistically significant using the variance ratio

test at 5% level of significance

Results and discussions

The three varieties showed differences in time of first bud appearance (Fig.1) The highest level of sprouting (bud appearance) in all the three varieties were registered between 10 to 21 days after grafting. Beyond 21 days, the rate of bud sprouting reduced considerably. Compared to other varieties, Kate registered the earliest time of bud sprouting, with 3 seedling buds sprouting at 11 days. This was 2 days earlier than Ssu that sprouted at 13 days. Bire registered the latest first bud appearance of 14 days. Cumulative number of seedlings that sprouted after grafting among the three varieties registered different results (Fig. 2). By 17 days, 22 seedlings of Kate variety had sprouted, while Ssu registered 14 seedlings by 20 days. The lowest cumulative numbers of seedlings was registered in Bire variety, with only 9 seedlings sprouting by 18 days after grafting.

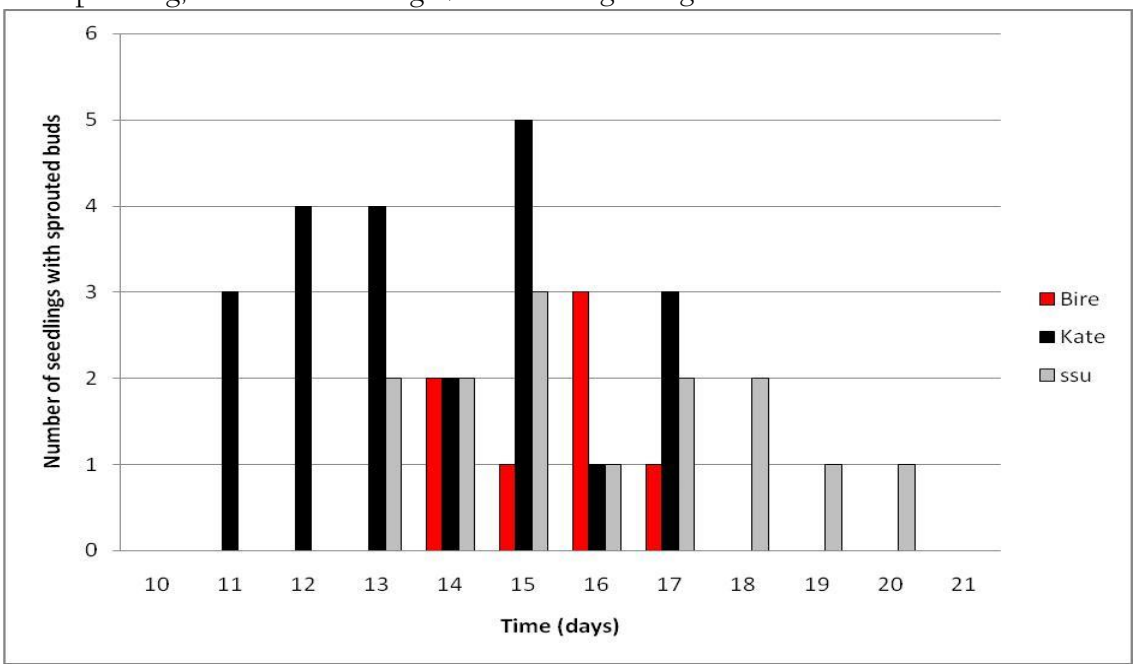

Fig 1. Time of first bud sprouting for the different varieties

Fig 2. Cumulative number of seedlings with sprouted buds after grafting

Fig. 3 shows the percentage survival of the different mango varieties to grafting. From the results of the experiment, 70% survival rate was recorded in the Kate variety, Ssu/Lubere registered a much lower rate of survival of with 46% and Bire registered the lowest rate of 30% within the 4 weeks of management. This may be due to the different levels of compatibility of the three different variety scions with the Kagogwa rootstock. Andrew and Marquez (1993) as cited by Festus, 2007 reported that hormonal imbalance between stocks and scions are involved in graft incompatibility. Phenolic compounds like flavonoids in the plant are also known to inhibit callus formation and growth, and callus growth is a prerequisite for union healing and graft establishment.

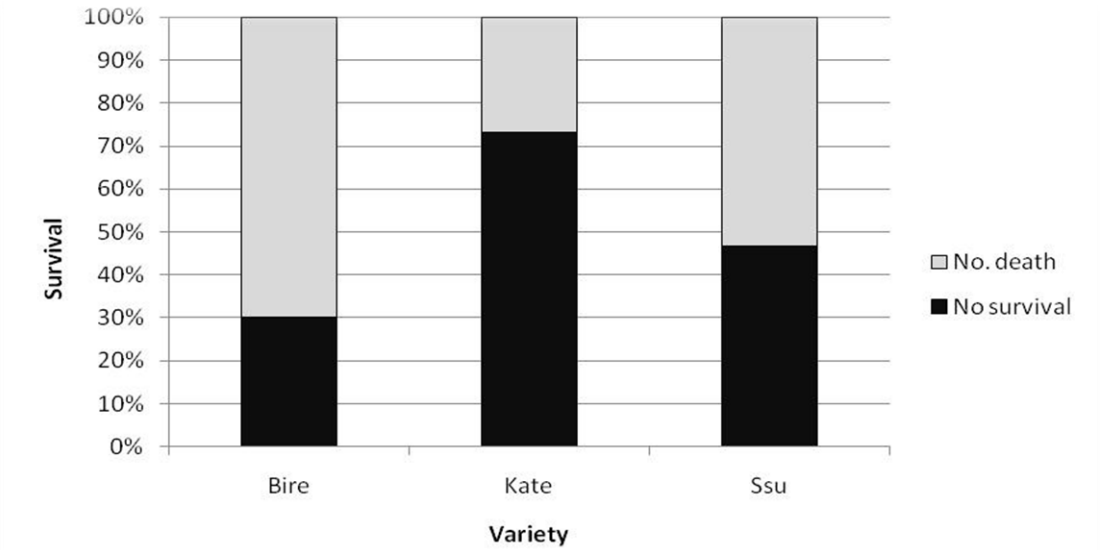

Fig. 3. Percentage survival per cultivar used

Individual blocks of the three mango varieties arranged in a randomized design showed a difference in survival (Fig 4). Kate variety registered the highest level of survival in all thethree blocks in the setup. Bire and Ssu registered a low and lower survival rates respectively. Leonardi and Romano (2004) reported that the survival ratio is related to the different aspects concerning plant growth phase, size and cut characteristics.

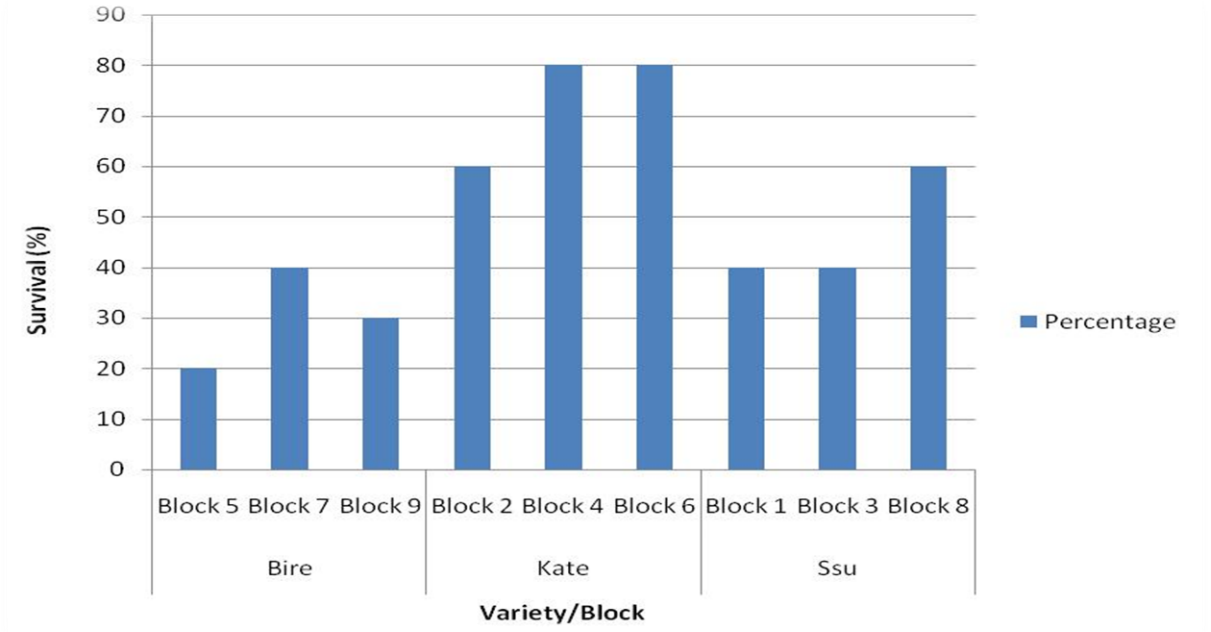

Fig 4. Percentage graft survival per block of the three varieties

There was no significant difference in leaf sizes at 5% level of significance (P>0.33) among the three mango varieties. The insignificance in the leaf sizes may be due to similar conditions provided for seedling growth were exposed to and enlargement for grafts that were successful. Successful grafts were those that had sprouted and actively growing by 4 weeks of management. Growth increase in the scion length was calculated by subtracting the initial from final measurements.

$$Scion\ growth = Final\ length - Initial\ length$$

A highly significant difference was recorded for scion length increase among the three varieties when subjected to analysis of variance at 5% level of significance (P < 0.0001). This may be due to genotypic difference of the three varieties as similar rootstocks and uniform environmental conditions were provided for growth. This consequently led to difference in rate of wound healing and the sprouting of buds. Similarly a significant difference was observed with the time in which the buds of the respective mango varieties sprouted (P<0.003)

Table 1. Summary for ANOVA for the three mango verities to bud sprouting, wound healing and scion length increase.

Groups	Count	Sum	Average	Variance	P value	F -crit
Time of bud sprouting						
Bire 1st Bud opening (days)		144	16	2.25		
Ssu 1st Bud opening (days)	14	224	16	4.923077	0.00371	3.225684
Kate 1st Bud opening (days)		291	13.8571	3.928571		
Leaf size						
Bire	3	23.7	7.9	4.33		
Suu		103.5	9.40909	15.92891	0.33141	3.294537
Kate	21	225.2	10.7238	11.1289		
Scion length increase						
Bire		13.8	0.46	0.795586		
Ssu	30	26.5	0.88333	0.798678	0.000118	3.101296
Kate		47	1.56667	1.196782		

The values obtained were at 5% level of significance (P < 0.05)

Conclusions and recommendations

Graft success and wound healing of mangoes under nursery conditions greatly depends on the variety used. Given the significant differences observed on time of bud sprouting, scion length increase and percentage survival. The high survival was due to quick wound response by the necrotic layer cells in callus formation. From the three varieties used in the experiment, Kate variety is the most compatible with the local "Kagogwa" rootstocks, followed by Ssu while Bire scions are the least compatible with the local rootstock. Graft success may be dependent on the increase in scion length because there was a significant difference between varieties on the success of the graft. However, the findings of this research does not mean that farmers trying to propagate mangoes through grafting should abandon the incompatible scions-rootstock combinations (Bire-Kagogwa in this case). They should rather aim at increasing survival at the nursery stage through manipulating the genotype-environment interaction. Since farmers have less control on the genotype, they should focus on providing the best environment for seedling survival; adequate water for the seedlings, using sharp knives in cutting, optimum humidity.

Further studies are needed to determine

varietal performance of other mango varieties (if not all) to grafting, based on scion- rootstock compatibility since only three varieties were used in this experiment. Also studies to improve success of less compatible cultivars (rootstocks and scions) will be very helpful in minimizing seedling death at the nursery. Improving compatibility could be done through reducing phenolic compounds like flavonoids in the seedlings or increasing the rate of callus formation

Acknowledgements

The author acknowledges Dr Elizabeth Balyejusa Kizito for the technical guidance and valuable comments during the experiment and thesis writing. Thanks also go to Loyal Plants tree nursery for providing the screenhouse facility

References

Abd El-Zaher, M.H. (2008). Using the Grafting for Propagation of the Jackfruit and Producing the Rootstocks for the Grafting. Cairo University, Egypt .American-Eurasian J. Agric. & Environ. Sci., 3 (3): 459-473. IDOSI Publications

Abd El-Zaher, M.H., (2004). A comparative study on polyembryonic rootstocks grafting of three mango cultivars. Journal of Agricultural Science. Mansoura University., Egypt, 29 (6): 3463-3479.

Akinnifesi, K., Simon, A.M., Gudeta.S. andAjayi,C.O.(2010). Rootstock growth and development for increased graft success of mango (Mangiferaindica) in the nursery.African Journal of Biotechnology Vol. 9 (9), pp. 1317-1324.

Baita, H.U., Manga, A.A. and Mustapha, Y.(2005). Evaluation of Different Morphotypes of Mango (MangiferaIndica L.) for use as Rootstock In Seedlings Production. Bayero Journal of Pure and Applied Sciences, 3(1): 79 – 82

Barnet,J. and Kindle,T.(2000). Causes of graft failure in walnut (JuglansregiaL.)Unpublished PhD thesis.Department of Agriculture.The University of Reading.

Bekhradi, F., Kashi.A, &Delshad, M. (2001).Effect of three cucurbits rootstocks on vegetative and yield of 'Charleston Gray' watermelon.International Journal of Plant Production.Accessed online from www.ijpp.info.

Chia, C.L. and Wanitprapha, K. (1991). General Crop Information. Family : Anacardiaceae accessed from www.cropknowledgemaster.com
Crasweller, R.M. (2005). Grafting and Propagagting Fruit Trees. Penn State College of Agricultural Sciences research. Accessed online from www.agsci.psu.

Degani, C., Cohen, M., Reuveni, O.,El-Bastri, R., and Gazit., S (1993) Frequency and Characteristics of zygotic Seedlings from Polyembryonic Mango Cultivers, determined using Isozymes as Genetic Markers. Acta Horticulturae 341, 78-85.

Donald, C. (1969). Graft Union Formation in Douglas fir. U.S Department of Agriculture.American Journal of Botany.Vol.56 (3).pp 285-289

Dormling, I. (1963). Anatomical and histological examinations of the union of scion and stock in grafts of Scots pine (Pinussylvestris). Corvallis, Oregon

Ezzahouani, A. and L.E. Williams. 1995. The influence of rootstocknon leaf water potential, yield, and berry composition of Ruby Seedless grapevines. Am. J. Enol. Vitic. 46:559–563.

FAO (Food and Agriculture Organization of the United Nations). 2001. FAOSTAT 2001 database. Rome, Italy: Food and Agriculture Organization of the United Nations, http://apps.fao.org/default.htm

Fruit Sub Sector Market Study.(2006). Final Report. FIT Uganda Limited

Gonzalez, A., Coulson, M. And Bratell, R.(2002) Develpment of DNA Markers (ISSRs) in Mango. Acta Horticulturae 575, 139-143
Karl, J.S., Muhammad.T.I. & Peter R. C. (2000).Light and temperature effects on shoot fruitfulness in Vitisvinifera. Horticulture Unit, PMB Merbein,Vic.Australiapp 99-105

Mabberly, D.J. (1997). The plant Book. Cambridge, UK: Cambridge University Press.

Nito, N., Han, S.H. and Katayama,Y. (2005). Evaluation of graft compatibility for taxonomic relationships among species of the orange subfamily.Acta Hort. 692:85-89.

Pina, A, Errea, P (2005).A review of new advances in mechanism of graft compatible – incompatible in Prunusspp. Sci. Hort. 106: 1-11.