

## **Physical injury reduction in mango fruit using improved harvesting methods**

**Mohamed E. Elkashif<sup>2</sup>, Tawhida B. Mohamed<sup>1</sup> and Osman M. Elamin<sup>2</sup>**

<sup>1</sup> Ministry of Agriculture, Irrigation and Forestry, Gezira State, Sudan.

<sup>2</sup> Faculty of Agricultural Sciences, University of Gezira, Wad Medani, Sudan.

### **ABSTRACT**

The traditional method of harvesting mango fruit in the Sudan is done by snapping the fruits by a hook attached to a long pole. The drop of fruits to the ground causes bruises and injuries to the fruits, making them unattractive and unmarketable with a short shelf-life. An experiment was conducted in a private orchard along the Blue Nile bank, Gezira State, Sudan, during the seasons 2012 and 2013. The objective of this work was to find out the effects of an improved picking pole and fruit receiving treatments on the reduction of harvest losses in fruits of three mango cultivars. Treatments consisted of three mango cultivars, namely, Abu Samaka, Alphonse and Kitchener, two types of picking poles; the traditional picking pole and improved picking pole and four treatments: The fruits were dropped directly on the ground (control), fruits were received on either a stretched sheet of cloth, a sponge mattress or a long tapering plastic mesh sleeve fixed to a ring attached to the picking poles. Treatments were arranged in a split-split plot design with three replicates. Cultivars were assigned to the main plots, picking poles to the sub-plots and receiving treatments to the sub-sub plots. Results showed that the improved picking pole resulted in significantly lower weight loss as compared to the traditional picking pole. The cultivar Abu Samaka showed significantly higher weight loss as compared to the other two cultivars. The highest percentage of weight loss was obtained when the fruits were allowed to fall directly on the ground (control), followed by the sheet of cloth and finally sponge mattress, whereas the long sleeve treatment resulted in the lowest weight loss. The improved picking pole resulted in the lowest physical injury, while the traditional picking pole resulted in the highest.

The improved picking pole equipped with a long sleeve resulted in the lowest physical injury, followed by the sheet of cloth treatment, the sponge mattress, whereas, dropping the fruits directly on the ground resulted in the highest physical injury. Abu Samaka cultivar had the highest percentage of physical injury, followed by Alphonse and then Kitchener cultivar. Shelf-life was significantly extended by using the improved picking pole coupled with receiving fruits in the long sleeve. However, the long sleeve fruit receiving treatment took the longest time to harvest 100 mango fruits under both types of picking poles. It is recommended to harvest mango fruits using the improved picking pole coupled with receiving fruits in a long plastic mesh sleeve for the reduction of harvest losses.

## INTRODUCTION

The mango fruit is one of the most important fruits in the Sudan and constitutes more than 50% of Sudanese horticultural exports. The main mango producing States in the Sudan are South Kordofan, Sennar, Blue Nile, Gedarif, Kassala and the River Nile.

Mango harvesting methods vary with consumption patterns and distance to markets. Internationally, mangoes are carefully harvested in order to avoid physical damage which results from the harvest operation. Therefore, harvesting crews use ladders and picking baskets to reduce physical injury to mango fruit. Also, they use motorized picking platforms known as cherry pickers which can be raised, lowered and moved by an operator in the picking platform (Gupta *et al.*, 2001).

Generally, the quality of mango fruits in the Sudan, whether exported or locally marketed, is very poor. This is mainly due to post-harvest losses caused by physical injury such as bruising, scratching and wounding resulting from improper harvesting methods and rough handling. Post-harvest losses in mango in the Sudan have been estimated in the range of 25-40% from harvest to consumption (Elkashif *et al.*, 2003).

Mangoes are traditionally picked in the Sudan by using long picking poles. These poles have hooks which snap down the fruits violently. The hook causes injury to the shoulder of the fruit, which drops down from the tall trees to the ground and thus subjected to bruising and wounding.

This considerable physical injury makes them unattractive, with a short shelf-life and unacceptable in international markets. Furthermore, when the peel is broken, the fruit becomes susceptible to decay and rot caused by micro-organisms (Elkashif *et al.*, 2010; Abu-Goukh and Mohamed, 2004).

Hence, there is an urgent need for improved mango harvesting techniques in the Sudan in order to reduce harvesting losses and improve fruit quality, especially those fruits intended for export. Therefore, the objective of this research was to reduce harvest losses in mango fruits using improved harvesting methods.

## MATERIALS AND METHODS

An experiment was conducted in a private orchard along the Blue Nile bank in Gezirat Alfeel, Gezira State, Sudan, during the seasons 2012 and 2013 to determine the effects of improved harvest methods on the reduction of physical injury in mango fruit of three selected mango cultivars.

### Treatments

#### 1. Cultivars

Cultivars used in this study were Abu Samaka, Alphonse and Kitchener.

#### 2. Picking poles

The fruits were harvested using two types of picking poles, namely, the traditional picking pole and an improved picking pole which consists of a cutter blade made of steel.

#### 3. Fruit receiving treatments

Fruits harvested either by the traditional or improved picking poles were received on the following treatments:

- Fruits were dropped directly on the ground (control).
- A sheet of cloth of the dimensions of 1.5x 2.0 m was stretched by four laborers under the tree to receive the falling fruits.
- Sponge mattress of the dimensions of 190x90 x7 cm was placed under the trees to reduce the impact of falling of the fruits.
- A sleeve made up of a plastic mesh, four meters long, was attached to a circular metal ring (27cm) which was fixed to both types of picking poles. The sleeve narrows down gradually till its diameter becomes slightly larger than the diameter of a large mango fruit (12 cm). Fruits harvested using the picking pole travel

through the sleeve which slows down their speed of falling and thus reach the ground slowly and gently without a noticeable falling impact. Treatments were arranged in a split-split plot design with three replicates. Cultivars were assigned to the main plots, picking poles to the sub-plots and fruit receiving treatments to the sub-sub plots. Data taken consisted of the following:

- Weight loss: Fruits were washed, disinfected with Na hypochlorite, packed in cartons and held at 18°C. The cartons were initially weighed and then weighed every two days till the fruits reached the fully ripe stage.

$$\text{Weight loss (\%)} = \frac{\text{Initial weight} - \text{weight at time (t)}}{\text{Initial weight}} \times 100$$

- Immediate physical injury of fruits which was obvious during the harvest operation. Number of physically injured fruits at the time of harvest was counted and percentage of immediate physical injury was calculated for each treatment as follows:

$$\text{Immediate physical injury (\%)} = \frac{\text{Number of injured fruits} \times 100}{\text{Total number of fruits harvested}}$$

- Latent injury, which is defined as that kind of injury which was not evident at the time of harvest, but appeared later during storage, howling symptoms of brown

- spongy tissue in fruits. It was calculated as follows :

$$\text{Latent injury (\%)} = \frac{\text{Fruits with latent injury} \times 100}{\text{Total number of fruits}}$$

5. Time needed to harvest 100 fruits in each treatment.
6. Shelf life: Mango fruits were washed, disinfected with Na hypochlorite, packed in cartons and held at 18°C. Fruit shelf life was determined by recording the number of days from harvest till fruits reached the fully ripe stage.

#### **Statistical analysis**

Data were analysed using the standard analysis of variance procedure and means were separated using Duncan's Multiple Range Test at 5% level of significance.

## **RESULTS AND DISCUSSION**

This experiment was conducted during the two consecutive seasons of 2012 and 2013. Since the results of both seasons were similar, only the results of the first season will be reported.

#### **Effects of harvesting methods on weight loss**

Figure 1 shows the effects of harvesting methods on weight loss (%) of mango fruits. The improved picking pole with a cutter blade resulted in significantly lower weight loss compared to the traditional picking pole. This was due to the fact that the improved picking pole caused less physical injury to fruits and hence lost less water than those fruits harvested by the traditional pole. These results were in agreement with those obtained by Abu-Goukh and Mohamed (2004) who showed that post-harvest weight loss in mango was significantly reduced when improved harvesting methods were used. Gupta *et al.* (2001) found that weight loss in mango fruit was higher when fruits were picked using the traditional mango picker compared to improved equipment. Similar results were obtained by Sapovadia *et al.* (2004). Sargent and Sidahmed (1987) reported that improper harvesting methods resulted in mechanical damage which speeded up the rates of respiration and water loss. Pruthi (1992) and Wasker *et al.* (2004) found that mango fruits harvested using improved methods recorded the minimum weight loss. Similarly, Kader *et al.* (1985) found that bruising resulting from manual harvesting stimulated the respiration rate of fruits which accelerated fruit deterioration due to water loss.

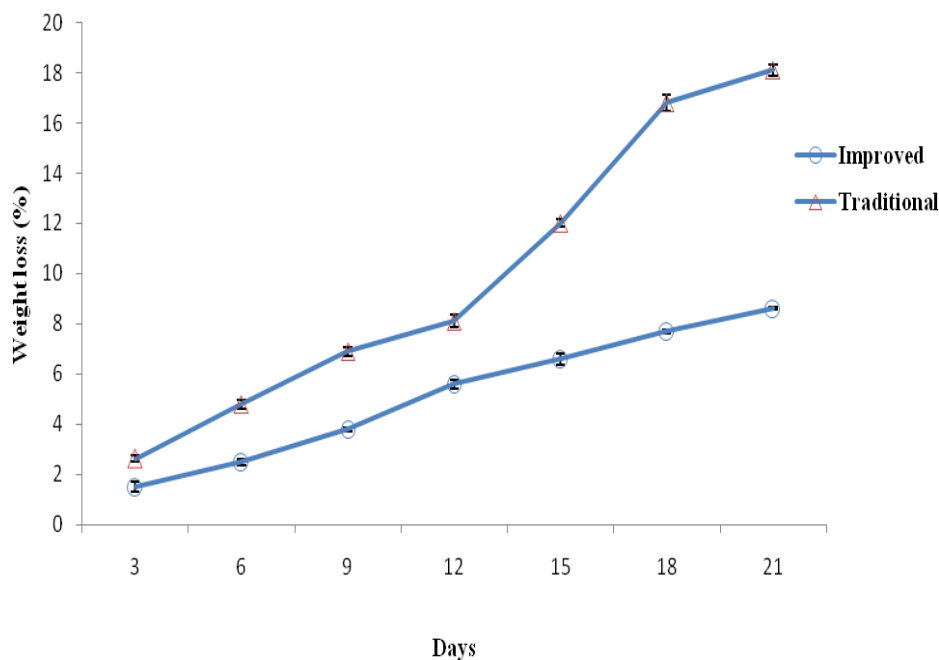
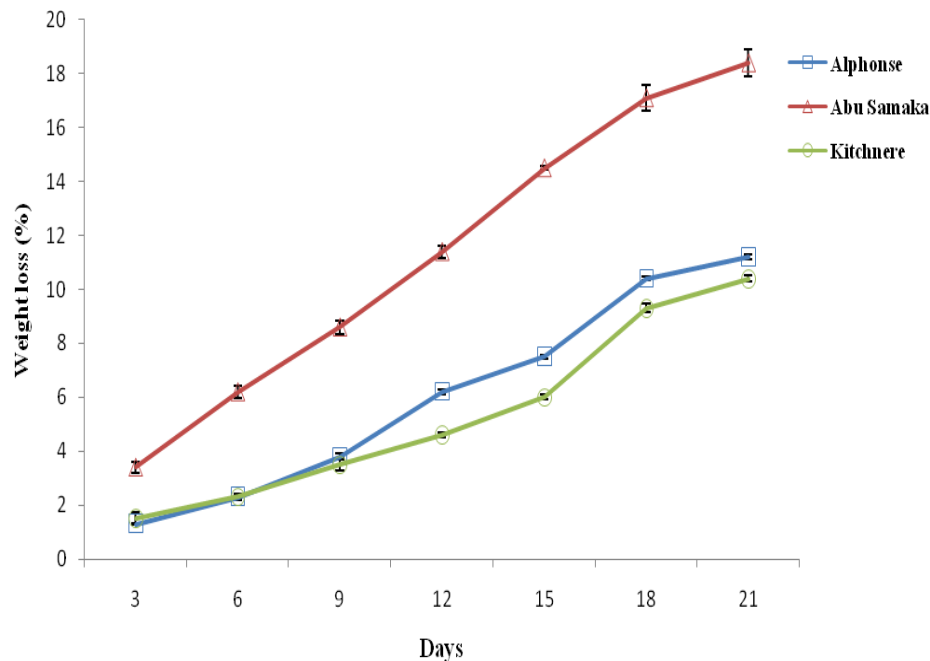


Fig. 1. Effects of harvesting methods on weight loss (%) of mango fruits.

### Effect of cultivars on weight loss

Figure 2 shows significant effects of cultivars on weight loss of mango fruits. The cultivar Abu Samaka showed significantly higher weight loss as compared to the other two cultivars. This was because of the large size and heavy weight of Abu Samaka fruits, which when they fell down on the ground, they were subjected to physical injury which accelerated the rate of water loss. In contrast, Alphonse and Kitchener cultivars, which were smaller in size and lighter in weight than Abu Samaka, were not subjected to considerable physical injury and, hence lost less weight. Adam (2008) concluded that physical damage of mango fruits resulted in significantly higher weight loss and he suggested that it could be reduced by improved harvesting methods, careful handling and proper packaging at all stages of packinghouse operations.



### Effects of fruit receiving treatments on weight loss

Figure 3 shows significant effects of fruit receiving treatments on weight loss of mango fruits. The highest percentage of weight loss was obtained when the fruits were allowed to fall directly on the ground (control), followed by receiving fruits on a sheet of cloth and then sponge mattress, whereas the long sleeve treatment resulted in the lowest weight loss. In the control treatment, mango fruits lost the highest weight because they fell directly on the ground, became physically injured and hence lost water, whereas the fruits which were received in the sleeve lost less weight because the long sleeve prevented the fruits from falling directly on the ground and were not physically injured. The fruits were subjected neither to impact injuries nor to hitting the branches while falling down. These results were in agreement with those reported by Elkashif *et al.*, (2010) and Abu-Goukh and Mohamed (2004) who showed that harvesting mango fruits using improved techniques resulted in significantly lower weight loss than traditional methods.

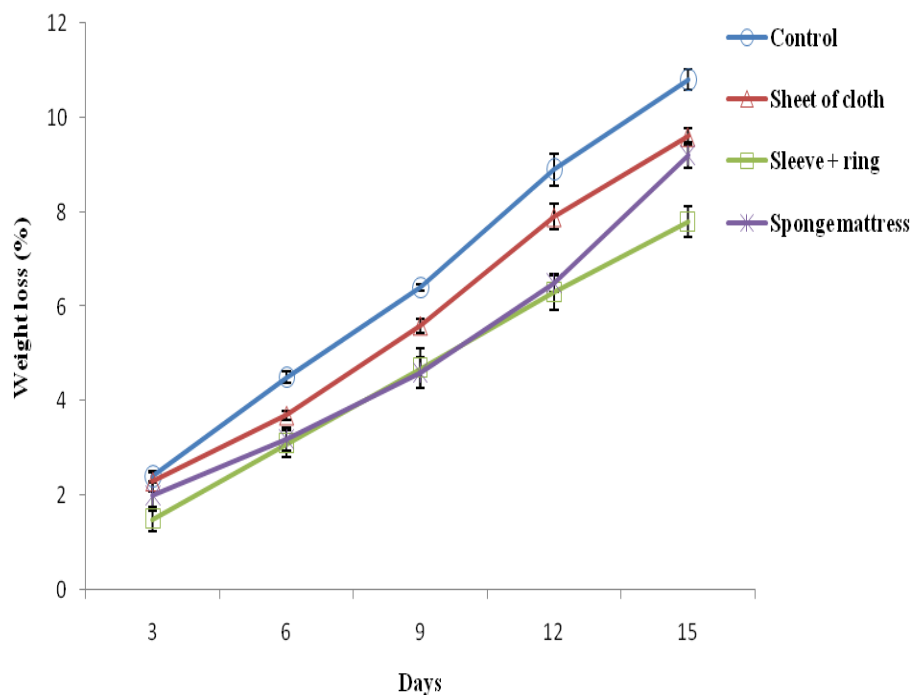
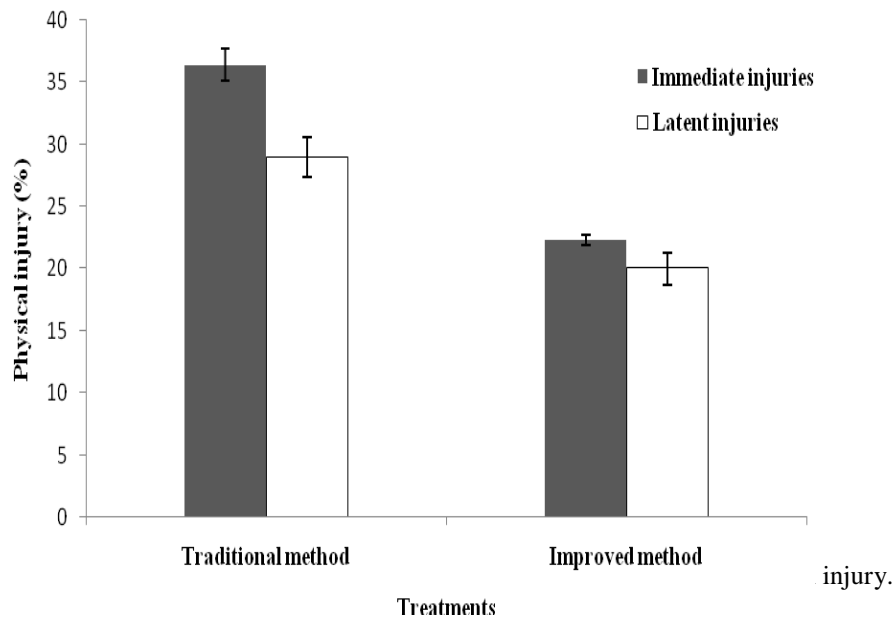


Fig. 3. Effect of fruit receiving treatments on weight loss (%) of mango fruits.

### Effects of harvesting methods on immediate and latent physical injury

Figure 4 shows significant effects of harvesting methods on immediate and latent physical injury. The improved picking pole resulted in the lowest immediate and latent physical injury, while the traditional picking pole resulted in the highest physical injury. The improved picking pole, which has a sickle blade, cuts the pedicel smoothly without a hard pull, and then the fruits fall on the receiving treatments, thus reducing physical injury. Sapovadia *et al.* (2004) stated that the improved picking pole saved time and protected the fruits from mechanical damage. It also protected the operators hands from the sap which oozed out from the point of detachment in fruits.

Fruits harvested using the improved picking pole had stalks which were most desirable for export quality; such fruits were less prone to stem end rot and other storage diseases (Elkashif *et al.*, 2010). Gupta *et al.* (2001) reported that fruits harvested using the traditional method were without stems and had sap burns. Fruits harvested using traditional picking poles were mostly injured by the end of the hook or by hitting the branches and most of them were without stalks which resulted in decay, poor quality and fetched low prices (Elkashif *et al.*, 2010).



#### Effects of fruit receiving treatments on immediate and latent physical injury

Figure 5 shows that the improved picking pole equipped with a long sleeve held open by a ring resulted in the lowest physical injury and the fruits were of high quality and excellent appearance. The control treatment, where fruits fell directly on the ground, showed the highest of both types of injury, followed by the sheet of cloth treatment which was stretched under

the trees to receive the harvested fruits. These results confirmed the findings of Elkashif *et al.* (2010) who found that using a straw mattress to receive the mango fruits decreased the percentage of physical injury compared with fruits falling directly on the ground. Waskar *et al.* (2004) reported that mango fruits harvested using improved techniques, were free from physical injury, post-harvest diseases, were not shriveled, firm, attractive in appearance and had an extended shelf-life compared to those harvested using the traditional picking pole.

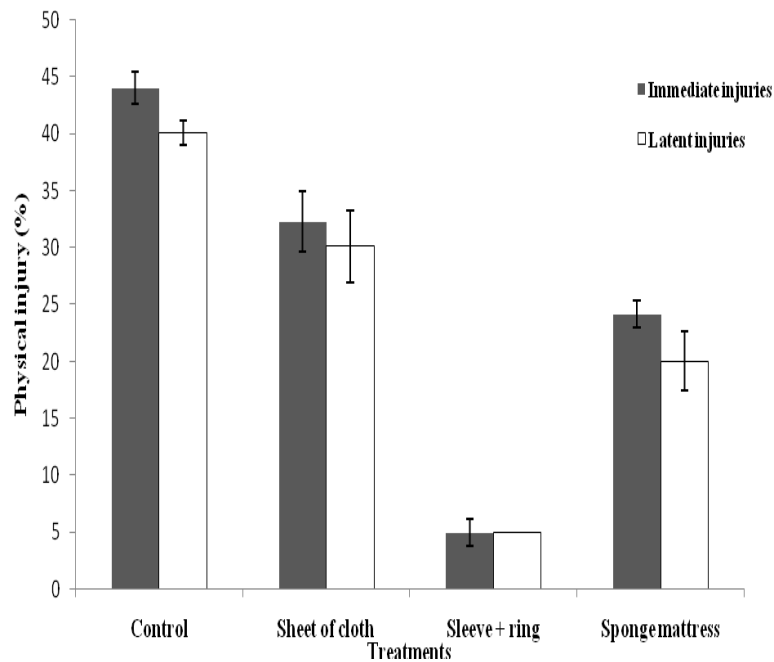
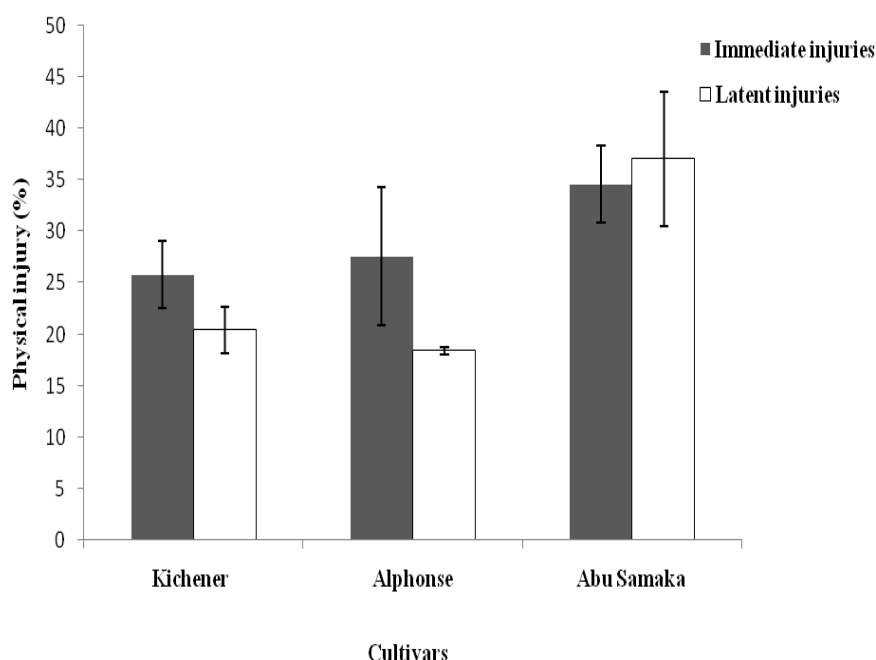


Fig. 5. Effects of mango fruit receiving treatments on immediate and latent physical Injury.

#### Effects of cultivars on physical injury

Figure 6 shows that Abu Samaka cultivar had the highest percentage of both types of physical injury followed by Alphonse and then Kitchener cultivar. Abu Samaka cultivar exhibited the highest percentage of physical injury due to its large size and heavy weight. However, Kitchener cultivar

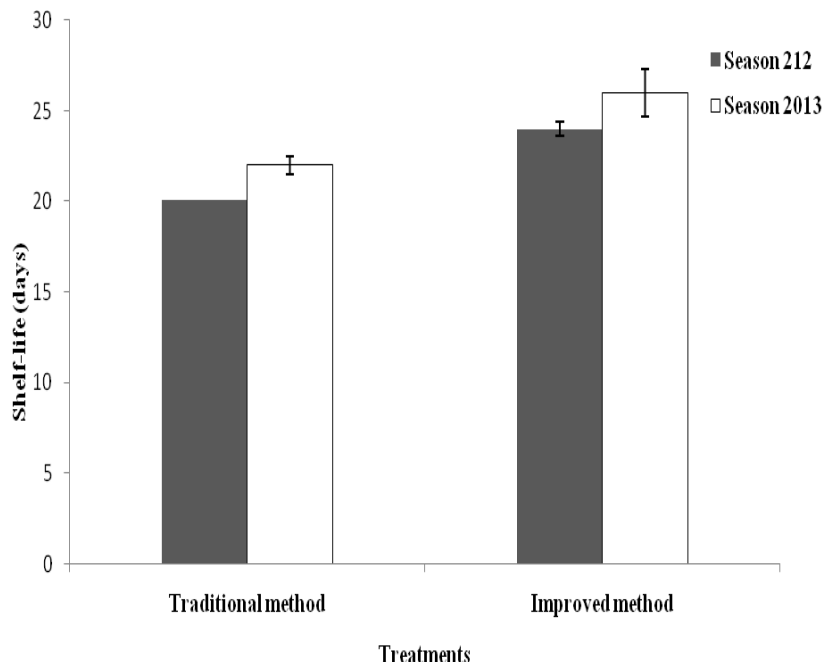
showed the least physical injury due to its small size. Similar results were reported by Elkashif *et al.* (2010) who found a direct relationship between physical injury and fruit size. This was also supported by the results of the fruits of Alphonse cultivar which were small in size and had a low percentage of physical injury. These results were also in agreement with those reported by Adam (2008).



### Effects of harvesting methods on fruit shelf-life

Figure 7 shows the effects of harvesting methods on the shelf-life of mango fruits. Shelf-life is very important for mango fruits because a long shelf life will allow fruits to be transported to distant markets without noticeable signs of deterioration, especially when fruits were intended for export. Shelf-life was significantly extended by using the improved picking pole compared to the traditional one. This could be attributed to the fact that harvesting fruits using the improved picking pole resulted in the lowest physical injury and hence, the longest shelf life. However, harvesting mango fruits using the traditional picking pole had a high percentage of

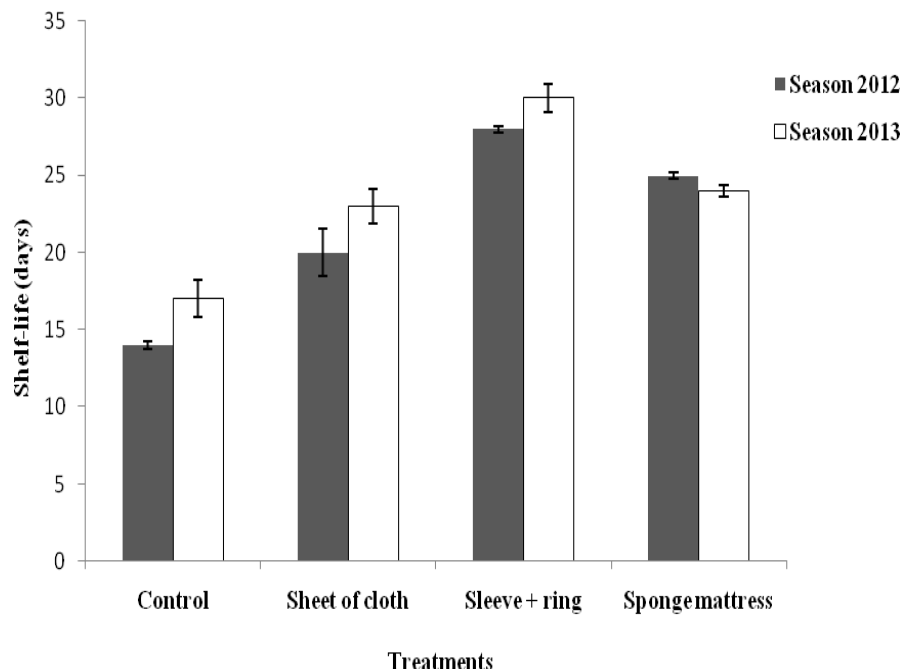
physical injury and most of them were without stalks and, therefore, they were subjected to post-harvest diseases, shriveling and a short shelf life. Gupta *et al.* (2001) reported that shelf life was affected by harvesting methods. They found that fruits harvested using the improved picking pole could be stored for 9 days without showing any symptoms of spoilage while those harvested using the traditional method deteriorated and rotted rapidly.



### Effects of fruit receiving treatments on fruit shelf-life

Fig. 8 shows that mango fruits received in the long mesh sleeve had significantly the longest shelf life, followed by the sponge mattress, the stretched cloth and the shortest shelf life was shown by the control treatment. This was because fruits received in the long sleeve were protected from all sorts of harvesting injuries. The fruits neither hit the branches while they were falling down, nor they dropped directly on the ground, which were the main causes of bruises and physical injury. Hence,

the fruits were free from scratches, blemishes, wounds and were healthy and had a long shelf life. Fruits received on the sponge mattress had a longer shelf life compared to other treatments because the sponge mattress cushioned the fruits and reduced physical injury. Fruits received on the sheet of cloth stretched under the tree were exposed to physical injury caused by the long stalks of fruits during dropping on each other and gathering in the middle of the stretched cloth which decreased their shelf life. Fruits which fell directly on the ground (control) had the shortest shelf life because they were subjected to considerable physical injury.



### Time to harvest 100 mango fruits

Table 1 shows highly significant interaction effects of harvesting methods and fruit receiving treatments on the time required to harvest 100 mango fruits. The long sleeve fruit receiving treatment took the longest time to harvest 100 mango fruits under both types of picking poles and in both seasons. This was because it took more time to place the ring under the

fruits and direct them through the sleeve. However, the traditional picking pole without any fruit receiving treatment took the shortest time to harvest 100 mango fruits. This was because the workers quickly pulled down the fruits without having to worry about placing them in the ring and down the sleeve or where they fall down.

It could be concluded that using the improved picking pole coupled with receiving harvested mango fruits in a long plastic mesh sleeve was the best method for the reduction of harvest losses.

Table 1. Interaction effects of harvesting methods and fruit receiving treatments on the time required to harvest 100 mango fruits.

Harvesting methods	Fruit receiving treatments	Required time (min)	
		2012	2013
Traditional picking pole	Control	4.1 g	4.6 f
	Stretched cloth	24.3 c	25.3 c
	Sleeve	39.5 a	33.4 a
	Sponge mattress	24.9 c	23.6 d
Improved picking pole	Control	6.8 f	6.0 e
	Stretched cloth	21.9 e	23.9 d
	Sleeve	30.7 b	31.2 b
	Sponge mattress	22.8 d	23.7 d
Significance level		***	***
SE <sub>±</sub>		0.21	0.47
C.V.(%)		12.26	14.4

Means having the same letters in columns were not significantly different according to Duncan's Multiple Range Test at 5% level of significance.

\*\*\* indicate significance at 0.1% probability level.

## REFERENCES

- Abu Goukh, A.A. and H.I. Mohamed. 2004. Effect of harvesting method on quality and shelf-life of mango fruits. *Journal of Tropical Science* 44: 73-76.
- Adam, A.M. 2008. Reduction of harvest losses in mango (*Mangifera indica* L.) fruit using improved harvesting methods. M.Sc. Thesis, The National Institute for the Promotion of Horticultural Exports, University of Gezira, Wad Medani, Sudan.
- Elkashif, M.E., O.M. Elamin and T.B. Mohamed. 2003. Effects of Ethrel application and packaging on mango fruit quality. *Gezira Journal of Agricultural Science* 1(1): 52-62.
- Elkashif, M.E., A.M. Adam and O.M. Elamin. 2010. Reduction of harvest losses in mango (*Mangifera indica* L.) fruit using improved harvesting methods. *Gezira Journal of Agricultural Science* 8(1): 52-62.
- Gupta, R.A., R.M. Satasiya, N.K. Gontia and P. Mohnot. 2001. Development and Testing of Tractor mounted Position for Mango Harvesting. *Agricultural Mechanization in Asia, Africa and Latin America* 35(1): 28-32.
- Kader, A.A., R.E. Kmire, F.G. Mitchell, M.Z. Reid, N.F.S. Sommer and J.F. Thompson. 1985. Post-harvest technology of horticultural crops. Special publication 3311. Cooperative Extension. University of California, Division of Agriculture and Natural Resources.
- Pruthi, J.S. 1992. The Mango Book 1. Production, postharvest technology and export marketing. Agricultural and Processed Food Products Export, Development Authority. New Delhi, India. P. 85.
- Sapovadia, B.D., R.A. Gupta, H.N. Patel and S.P. Rund. 2004. Design and development of a mango harvesting device. *Agricultural Mechanization in Asia, Africa and Latin America* 32(1): 31-34.
- Sargent, M.J. and O.A. Sidahmed. 1987. Improving Postharvest Handling. Published by the University of Gezira, Wad Medani, Sudan.
- Salunke, D.K. and B.B. Desai. 1984. Post-harvest biotechnology of fruits Vol. I Boca Raton., FL: CRC, P. 168.
- Waskar, D.P., S.D. Masalkar, R.S. Gaikwad and S.V. Dawame. 2004. Effect of method of harvesting on post-harvest loss reduction and extension of shelf-life of mango. Maharashtra, India. Pp. 662-668.

## تقليل الإصابة بالأضرار في ثمار المانجو باستخدام طرق محسنة للحصاد

محمد الحاج الكاشف<sup>1</sup> وتوحيدة بابكر محمد أحمد<sup>2</sup> وعثمان محمد الأمين<sup>1</sup>

<sup>1</sup>كلية العلوم الزراعية، جامعة الجزيرة ، واد مدني ، السودان.  
<sup>2</sup>وزارة الزراعة و الري و الغابات ، ولاية الجزيرة ، السودان.

### الخلاصة

حصاد المانجو في السودان يتم باستخدام الخطاف وهو عبارة عن عصا طويلة مثبت بها خطاف معقوف وهذا يؤدي إلى سقوط الثمار على الأرض وإصابتها بالجروح والخدوش مما يقلل من نوعيتها وعدم صلاحيتها للتسويق. أجريت تجربة بواد مدني، ولاية الجزيرة، السودان، في 2012 و 2013. الهدف من الدراسة هو إيجاد تأثير الخطاف المحسن ومعاملات إستقبال الثمار على تقليل الأضرار التي تصيب الثمار أثناء الحصاد لثلاثة أصناف من المانجو. إشتملت المعاملات على ثلاثة أصناف من المانجو وهي أبوسمكة والفونس وكنشنر ونوعين من الخطاف وهما الخطاف المحسن والتقليدي وأربعة معاملات لإستقبال الثمار وهي سقوط الثمار على الأرض مباشرة (شاهد) واستقبال الثمار على قماش مشدود تحت الشجرة أو على مرتبة إسفنجية أو في خرطوم من شبكة البلاستيك مثبت على الخطاف. أستخدم تصميم القطع المنشقة المنشقة بثلاث مكررات. كانت أصناف المانجو القطع الرئيسية ونوع الخطاف القطع الفرعية ومعاملات إستقبال الثمار القطع الفرعية. أظهرت النتائج أن الخطاف المحسن أعطى معنوياً أقل نسبة لفقدان وزن الثمار بالمقارنة مع الخطاف التقليدي. الصنف أبوسمكة أعطى معنوياً أعلى معدل لفقدان الوزن مقارنة بالأصناف الأخرى. بالنسبة لمعاملات إستقبال الثمار، فإن وقوع الثمار على الأرض مباشرة أعطى أعلى معدل لفقدان الوزن ويليه وقوع الثمار على القماش ثم مرتبة الإسفنج، بينما أعطى إستقبال الثمار في خرطوم البلاستيك أدنى معدل لفقدان الوزن. الخطاف المحسن أعطى أدنى نسبة للإصابة بالأضرار مقارنة بالخطاف التقليدي. كذلك الخطاف المحسن المزود بخرطوم البلاستيك أعطى أدنى نسبة للإصابة بالأضرار يليه القماش المشدود تحت الشجرة ثم مرتبة الإسفنج ، بينما أدى سقوط الثمار على الأرض أعلى نسبة للإصابة بالأضرار. الصنف أبوسمكة أعطى أعلى نسبة للإصابة بالأضرار يليه الصنف الفونس ثم كتنشر. الخطاف المحسن المزود بخرطوم البلاستيك أعطى أطول فترة صلاحية للثمار ولكنه استغرق وقتاً أطول لحصاد مائة ثمرة. بناءً على هذه الدراسة فإنه يوصى بحصاد ثمار المانجو باستخدام الخطاف المحسن المزود بخرطوم البلاستيك لتقليل تلف الثمار.