J. Appl. Res Plant Sci. Vol. 5(1), 79-85, 2024, https://doi.org/10.38211/joarps.2024.05.212

Research Article

OPEN ACCESS

Available on https://www.joarps.org
Journal of Applied Research in Plant Sciences
(JOARPS)
ISSN: 2708-3004 (Online), 2708-2997 (Print)

Evaluation of Fruit Bunch Bagging Techniques for Improvement of Loquat Fruit Quality

Tanveer Hussain[1]*, Irfan Ali[1], Ijaz Ahmad[3], Mehwish Liaquat[1], Muhammad Tahir Akram[1], Adeel Anwar[2], Ghazal Rahim[4], Sana Asghar[5], Waqas Naseem[6], Aysha Manzoor[7], Faheem Khadija[8], Muhammad Saqib Naveed[7] and Imran Ali[1]

[1]Department of Horticulture, PMAS-Arid Agriculture University Rawalpindi, Pakistan
[2]Department of Agronomy, PMAS-Arid Agriculture University Rawalpindi, Pakistan,
[3]Department of Botany, Govt. Post Graduate College satellite Town, Gujranwala, Pakistan
[4]Directorate of Floriculture (Traing and Research) Punjab, Lahore
[5]Hill Fruit Research Satation Sunny Bank Murree, Pakistan
[6]Soil and Water Conservation Research Institute Chakwal, Pakistan
[7]Barani Agricultural Research Institute Chakwal Pakistan
[8]Senior Scientist, Mango Research Station Shujabad, Multan, Pakistan
*Corresponding author, e-mail: dr.tanveer005@uaar.edu.pk

Article Received 10-03-2023, Article Revised 10-10-2023, Article Accepted 21-10-2023.

Abstract

China is the leading country in the loquat (*Eriobotrya japonica* L.) production followed by Spain and Japan. In Pakistan it is mainly cultivated in two provinces i.e. Khyber Pakhtunkhwa and Punjab. Present study is aimed to standardize bagging techniques for loquat fruit to enhance quality. Five treatments such as control (unbagged), magazine paper bags, zip locked perforated plastic bags, Chinese paper bags and butter paper bags were used with three replications. Data were recorded for various parameters, including fruit firmness, fruit color, fruit size, fruit and seed weight, ascorbic acid (mg/100g), titratable acidity (%), TSS (°Brix), and reducing and non-reducing sugars. All treatments showed a significant effect on the differences in the evaluated parameters. It was observed that fruit size, fruit weight and ascorbic acid were enhanced when using magazine paper bags (MPB), while fruit firmness, total soluble solids and skin color showed better results in loquat fruits wrapped with zip-locked perforated plastic bags (ZLPPB) compared to the control (unwrapped fruit). Among the bagging treatments, it was revealed that titratable acidity was highest in butter paper bags. RCBD was used for this study. All the readings were subjected to ANOVA and LSD Test (Least Significant Difference Test) for comparison at a 95% level of confidence. In conclusion, fruit bagging at the early developmental stage of fruit in loquat plants with zip-locked perforated plastic bags (ZLPPB) and magazine paper bags (MPB) can be a good choice to enhace the quality of loquat fruit.

Keywords: Fruit bunch bagging techniques, fruit quality, protecting fruits,

Introduction

Loquat (*Eriobotrya japonica* L.) is a member of family *Rosaceae*, subfamily *Maloideae*. It was originated in China and then spread to the other countries of world (Zheng, 2007; Huang *et al*., 2007). Loquat is mainly grown in China, Japan, Pakistan, India, Brazil, Mauritius Island, Madagascar, United States, Australia and the Mediterranean countries (Vilanova *et al*., 2001; Li *et al*., 2007). World production of loquat is 549220 tons while area is 131260 hectares (Lin, 2007; Lin *et al*., 2007). In Pakistan it is considered as a minor fruit and grown only on 1678 hectares with the 13159 tons production (Akhtar, 2009). More than 98 % loquat grown in Punjab and KPK Province (MINFAL, 2009). It is cultivated in Punjab province at Murree foot hills (Chatter,Tret), Taxila, Kalar Kahar, Wah, Hassanabdal and Chakwal while in KPK loquat is being grown in Peshawar, Mardan and Harripur (Hussain, 2009). Loquat have malic acid, sucrose, laevulose and lower quantity of tartaric acid, succinic acid, minerals (P & Ca), vitamins (A, B & C), and various sugars (Karadeniz, 2002). It contains high concentration of carotenoids; fruit 1and tender leaves these may be used for the treatment of diseases. The leaves as well as kernel contain amygdaline, which is also called as anti-cancer vitamin (Tierra, 2005. Fruit bagging is a common technique in many fruits, used for protection of fruits from bird's attack, sun scard, hailstorm, frost, pests and diseases. Moreover, it changes the micro-environment of fruit during development, which applied numerous effects on quality and growth of many fruits (Li *et al*., 2008; Son and Lee, 2008; Guzman, 2004). Fruit bunch bagging saved the bunch from decreasing temperature such as in India (Gopalkrishna and Deo, 1960) and Australlia (Berril, 1956). According to Chillet and Jannoyer (1996), small climatic changes of fruit bunch favored and modify by fruit bunch bagging. Weight of fruit bunch enhanced by 18-23 percent while increasing the quality of fruit in Sri Lankan climate (Anon, 1995). In apple and Asian pear it is used for the making of unblemished and good quality fruit (Huang *et al*., 2007). Bagging of fruits encourages fruit pigmentation (Jia *et al*., 2005; Hu *et al*., 2001; Byers and Carbaugh, 1995) and reduces physical injury (Byers and Carbaugh, 1995). On the other hand, different types of bags have many physicochemical features for example heat conductance, vapor permeability, light transmittance and subsequently create differential effects on quality and microenvironment of fruits (Niu *et al*., 2003; Son and Lee, 2008). Many reports showed that bagging on fruits reduce total soluble solids (Huang *et al*., 2007). Bagging is effective for inhibition of diseases, insect pest, sunburn, fruit cracking, fruit shrinkage and lowers the fruit drop (Wu *et al*., 2004; Ping *et al*., 2005) and also effective for growing better quality perfect fruits (Kitagawa *et al*., 1992). Presently a research work is designed with the objectives to identify economical and suitable fruit bunch bagging techniques to get high value fruit. It is accepted that identification of suitable fruit bagging techniques will help to harvest fruit of high demand with better earnings.

Materials and Methods

The research work was carried out at Tret Fruit Research Station, Murree Hills, District Rawalpindi (Punjab), Pakistan. Loquat (*Eriobotrya japonica* L.) trees with the age of 20-25 years were selected for this study. Fruits were bagged two month before harvesting and firmly tied with rope to avoid entrance of water and insects. Standard cultural practices were applied to the entire experimental study. The detail of the treatments is as follows.**T_1:** Control (unbagged), **T_2:** Magazine paper bags (MPB) of 12 inch x 9 inch size with hole (2.5 inch x 1 inch) at the bottom of right side, **T_3:** Zip locked perforated plastic bags (ZLPPB) of 12 x 8 inches with four lines of pores (0.45mm) length wise,**T_4:** Chinese paper bags (CPB) of 12 x 9 inches with hole size 2.5 x 1inches at the right side of bottom, **T_5:** Butter paper bags (BPB) of 12 x 8 inche with hole (2.5 inch x 1 inch) at the bottom of right side. Chinese paper bag (CPB) and butter paper bags (BPB) were imported from china while Magazine paper bags (MPB) and Zip locked perforated plastic bags (ZLPPB) were acquired from the local market. For assessment of loquat fruit quality and analysis, fruits were harvested and shifted to postharvest Lab of Department of Horticulture, PMAS- Arid Agriculture University, Rawalpindi during 2011-12.

Physical quality parameters: After harvesting, loquat fruits were shifted to post-harvest laboratory for physical parameters. Fruit size was measured by using Vernier caliper. The color of loquat fruit skin was measured with a chromometer CR-400 (Konica Minolta Sensing, Inc., Japan). The fruit color changes *L**, *a** and *b** were measured from the blush side and non-blush sides. Firmness of fruit was recorded by using penetrometer.

Chemical quality parameters: The fruits from each treatment used for firmness test then juice was extracted from each lot by using juicer. The extracted juice was used for analysis of treatable acidity, total soluble solids and Sugars.

Titratable Acidity: The extracted loquat juice (10ml) mixed with 40 ml distilled water.. Two to five drops of phenolphthalein were added in the juice. A 10 ml aliquot was taken in a titration flask and then titrated against 0.1 N NaOH till permanent light pink color appears. Three readings were recorded from each replication of a treatment and acidity percentage as malic acid was calculated by using the following formula;

$$\% \text{ Titratable acidity} = \frac{\text{N/10 NaOH used} \times 0.0064}{\text{(Volume of aliquot taken)}} \times 100$$

Total Soluble Solids (°Brix): Total soluble solids (TSS) measured according to AOAC (1990) using hand refractometer at room temperature. The drop of extracted juice placed on absolutely dry refractometer prism and readings recorded in °Brix.

Reducing Sugars: Reducing sugars of juice estimated by the method described by Horwitz (1960). Ten ml juice sample was taken in 250 ml volumetric flasks to which 100 ml distilled water, 25 ml lead acetate solution and 10 ml potassium oxalate was added. Volume was made up with distilled water and filtered. In a conical flask, 10 ml of Fehling's solution was taken and boiled after adding some distilled water. Sample aliquot then be taken in a burette and let to run drop wise into the conical flask containing the Fehling's solution. While titrating, slow boiling was continued. On appearance of brick red color 2 to 3 drops of methyl blue were added and titration continued till again brick red color appears. Reading of sample aliquot used was noted and percent reducing sugars were calculated as below:

$$\text{Reducing sugars (\%)} = 6.25 \, (X / Y)$$

Where:

X = ml of standard sugar solution used against 10 ml Fehling's solution

Y = ml of sample aliquot used against 10 ml Fehling's solution.

Non- Reducing Sugars: Non-reducing sugars calculated by the following formula.

Non-reducing sugars (%) = [Total sugars (%) – Reducing sugars (%)] x 0.95

Statistical Analysis: RCBD was used for this study. The all readings were subjected to ANOVA and LSD Test (Least Significant Difference Test) for comparison at 95 % level of confidence as recommended by Chase and Bown (1997).

Results and Discussions

Firmness (N): All the bagging treatments show highly significant results for fruit firmness against unbagged or control treatment. The current results fully supported the results of Ding *et al*. (1998) he found that different types of bagging had major effect in fruits such as increase in firmness of fruit. Firmness in fruits bagged with zip locked perforated plastic bags was higher when compared with control and other bagging treatments. With increasing shelf life of polyethylene bagged fruit had greater decline in firmness (Jia *et al*., 2005). Whereas bagging with various techniques may have exerted differential sound effects on chemical composition of fruit (Wang *et al*., 2007). It is indicated that fruit firmness was found highest in zip locked perforated plastic bags (T_3) 2.66 and lowest fruit firmness of 0.94 in control. Basically firmness is related with fruit texture which reduces with ripening. A fruit may transform its quality through maturation, particularly at the stage of ripening when it may be converted into soft form and enhance the quality of fruit.

Skin Color of fruits: Color of fruit surface is one of the most key factors to observe the fruit maturity. It is major indication for marketable quality of fruit (Studman, 1994). The analysis of color is commonly an essential characteristic which determining the The The effectiveness of postharvest treatments of variety (McGuire, 1992). Durgac *et al*. (2006) were observed that with the ripening of fruit, reduction in moisture loss reduces (L*) value. It was evident that fruit skinlightness (L*) value in loquat fruit was higher with (T_3) Zip locked perforated plastic bags (53.77). Similar work is done by Xu *et al*. (2010) who observed that bagging enhanced the L* value (fruit skin lightness) which were greater in bagged fruit than in unbagged or control fruits of Ninghaibai and Baiyu loquat varities. Low light is recognized to enhance the humiliation of chlorophyll and retards synthesis of carotenoids in fruit peel. Highest fruit skin blush color (a*) value (10.28) was found zip locked perforated plastic bags (T_3) while fruit skin blush color (a*) value (4.74) was noticed in magazine paper bags (T_2). It was observed that control treatment had highest fruit skin ground color (b*) value (28.48). Significantly lower fruit skin ground color (b*) value (11.91) prevailed in fruits of magazine paper bags treatment (T_2). The effects were common among zip locked perforated plastic bags (T_3), butter paper bags (T_5) and Chinese paper bags (T_4) with fruit skin color (b*) values of 23.53, 20.55 and 15.46 respectively.

Table1. Effect of different bagging types on firmness and color of loquat fruit.

Bagging Material	Fruit firmness Newton (N)	Fruit color		
		L*	a*	b*
T1 Control (Unbagged)	0.94±0.03d	40.87±1.15e	8.54±0.26b	28.48±0.67a
T2 MPB	3.0±0.09c	44.86±1.05d	4.74±0.38d	11.91±0.28 e
T3 ZLPPB	2.66±0.06 a	53.77±0.99 a	10.28±0.30a	23.53±0.82b
T4 CPB	1.53±0.15c	47.61±0.51 c	6.69±0.70c	15.46±0.81d
T5 BPB	2.40±0.06 b	50.71±0.63 b	6.01±0.53cd	20.55±0.79c

Those means which are followed by similar alphabets are not much different from one another at 0.05 Prob. Value (LSD). ± = Std E.

Fruit size: Pearson and Robertson (1953) found that variations in fruit size are observed in initial growth by the degree of cell division. Size of the cell may also affect fruit size during different seasons. It showed that all the treatments had more fruit size relative to control. The maximum fruit size 32.48 mm was recorded in magazine paper bags (T_2) followed by 29.83 mm in zip locked perforated plastic bags (T_3). While fruit wrapped with Chinese paper bags (T_4) and butter paper bags (T_5) showed same effects with values of 26.42 mm and 25.04 mm respectively. The present findings are alike with the findings of Xu *et al*. (2010) that size and weight of the different fruits like pomegranate (Hussain *et al*., 1994) and banana (Hasan *et al*., 2001) and apple are affected by bagging (Arakawa *et al*., 1994).

Fruit weight: Fruit weight is very important factor related to yield. The highest significant fruit weight was found in magazine paper bags (T_2) followed by Chinese paper bags (T_4), zip locked perforated plastic bags (T_3) and butter paper bags (T_5) with values 26.69 g, 24.18 g, 20.46 g and 18.48 g respectively. Unbagged or control (T_1) recorded the lowest fruit weight 13.82 g. The weight of loquat increased when it is cover with different bagging materials (Xu *et al*., 2010), these results support the current findings that weight increase as compared with control. Current findings are also supported by the results of Chillet and Jannoyer (1996) that fruit weight was considerably high in fruits of bunches with covers compared to bunch with no covers.

Seed weight: The maximum average seed weight of loquat fruit (3.48 g) was recorded in control treatment followed by (3.01 g) butter paper bags (T_5), (2.59 g) Chinese paper bags (T_4) and (2.04 g) zip locked perforated plastic bags (T_3) respectively. While minimum average seed weight of loquat fruit (1.84 g) was recorded in magazine paper bags (T_2). The pulp of loquat is white to light yellow to orange and peel is smoothing to slightly downy and light yellow to orange (Nawaf *et al*., 2008).

Ascorbic acid (mg/100g):.Ascorbic acid contents as influenced by different bagging treatments showed that maximum ascorbic acid contents noted in magazine paper bags (T_2) 2.66 mg/100g while the minimum ascorbic acid contents noted in unbagged or control treatment (T_2) 2.09 mg/100g. Similar work is done by Xu *et al*. (2010) found that various type of bagging material increase the carotenoid and vitamin C contents as compared to unbagged or control treatment.

Table2. Effect of different bagging materialon fruit weight, seed weight and Ascorbic acid of loquat fruit.

Bagging Material	Fruit size (mm)	Fruit weight (g)	Seed weight (g)	Ascorbic acid (mg/100g)
Control (unbagged)	22.07± 0.41d	13.8 ±0.44e	3.73±0.24a	2.09±0.04d
T_2: MPB	32.48±0.78a	26.69±0.29a	1.84±0.08 d	2.68±0.04 a
T_3:ZLPPB	29.83±0.40 b	20.46±0.62c	2.04± 0.11cd	2.49±0.02b
T_4:CPB	26.42±0.49c	24.18±0.30b	2.59±0.20 bc	2.37±0.06bc
T_5:BPB	25.04±0.41c	18.48 ±0.83d	3.01±0.33 ab	2.25± 0.06 cd

Those means which are followed by similar alphabets are not much different from one another at 0.05 Prob. Value (LSD). ± = Std E.

Titratable acidity: Titrable acidity is the amount of organic acids existing in fruits. Titratable acidity is directly connected to amount of acid present in fruit (Kays, 1997). Acidity is often used as indication of maturity. Increasing in levels of acidity on 1st day of in immature fruit might be due to fermentation of sugars resulting in production of acids (Bhattacharya, 2004). Bagging treatments revealed that titratable acidity was maximum in Butter paper bag (T_5) with 0.29 percent reading compared to control with the value of 0.19%. Kim *et al*. (2003) also found that titrable acidity tended to increase by bagging treatments with yellow paper of low light transmittance. Whereas in the chemical composition of fruit, bagging with various bagging material have differential effects (Wang *et al*., 2007). Jia *et al*. (2005) indicated that in common titratable acidity was not affected by bagging. According to results reported by Reyes and Pauli (1995) titratable acidity is a role of fruit age rather than stage of ripening and this quality parameter is maintained during ripening. These results are also similar with Bashir *et al*. (2003) who found that in guava titratable acidity is improved up to a climacteric peak and decrease thereafter similar kinds of observations were found during ripening. Other findings also investigated that use of polyethylene bags minimizes decreases in organic acids (Ding *et al*., 1997).

Total soluble solids (ºBrix): Bagging data affected by various treatments revealed that the maximum values for TSS (Total soluble solids) 16.04 ºBrix was observed in zip locked perforated plastic bags (T_3) as compared to minimum value 7.04 ºBrix was found in unbagged or controlled fruit treatment (T_1). While fruit treated with Chinese paper bags (T_4) and butter paper bags (T_5) showed same effects with values of 10.00 ºBrix and 9.67 ºBrix respectively. The present research work also interprets that there was a slight and gradual increase in the total soluble solids with the passage of time but bagging did not show any remarkable increase in the TSS contents. These results are in line with Hofman (1997) who found that in general TSS was not generally affected by bagging.

Reducing Sugars: The results of different bagging treatments reducing sugar contents indicated that highest reducing sugar contents (1.83 percent) was noted in zip locked perforated plastic bags (T_3) in comparison with lowest reducing sugar contents (1.26 percent) observed by unbagged or control treatment (T_3). Current results are fully supported by the findings of Xu *et al*. (2010) who found that sugar components were supposed to be significant ensuring features of fresh fruit. However, various bagging techniques which can cause various effects on the compositions of soluble sugars such as Padmavathamma and Hulamani (2009) satated that total sugars differ extensively with bag color, whereas Yang *et al*. (1996) found that that bagging tended to lower the sugar components, whereas the sugar components were non significantly suffered by bag type.

Non Reducing sugars: Studied have shown that bagging develop an environment that uaually lowers components of sugars (Niu *et al*., 2003). The data showed that maximum non reducing sugar content were found in zip locked perforated plastic bags (T_3) with 16.07 percent value while lowest was observed in the butter paper bags (T_5) with value of 8.91 percent followed by magazine paper bags (T_2), chinese paper bags (T_4) and unbagged or control (T_1) with values of 13.83 percent, 11.51 percent and 11.13 percent respectively

.

Table 3. Effect of different bagging material on TA, TSS, RS and non-RS of loquat fruit.

Bagging Material	Titrateable Acidity (%)	Total Soluble Solids(%)	Reducing Sugar(%)	Non-Reducing Sugar(%)
T1Control (unbagged)	0.19 ± 0.00c	7.04±0.59 d	1.26±0.15c	11.13±0.77c
T_2: MPB	0.14±0.01d	13.03±1.01b	1.62±0.04ab	13.83±0.33b
T_3:ZLPPB	0.24±0.01b	16.04±0.90 a	1.83±0.07a	16.07±0.62 a
T_4:CPB	0.25±0.01ab	10.00±0.33 c	1.40±0.07 bc	11.51±0.73c
T_5:BPB	0.29±0.01a	9.67±0.55c	1.20±0.01c	8.91±0.56d
Those means which are followed by similar alphabets are not much different from one another at 0.05 Prob. Value (LSD). ± = Std E.				

Conclusion

It is concluded that fruit bagging at early developmental stage of fruit in loquat plant with zip locked perforated plastic bag (ZLPPB) and magazine paper bag (MPB) can be good choice to enhance the quality of fruit. Utilizing bagging techniques not only facilitates the production of premium-quality loquat fruit but also offers a viable means to increase profits for loquat growers, particularly advocating this practice for those engaged in organic fruit cultivation.

Conflict of interest:

All the authors have no conflict of interest.

References

Akhtar, A. (2009). Relationship of antioxidants with qualitative changes in local cultivars of loquat (*Eriobotrya japonica* L.) fruit during storage. Ph.D. Thesis. Deptt. Hort., PMAS Arid Agri. Univ. Rawalpindi, Pakistan.

Anon, (1995). Banana cultivation. Department of Agri. Peradeniya. 30p.

Arakawa, O., Uematsu, N., & Nakajima, H. (1994). Effect of bagging on fruit quality in apples. Bull Faculty Agric. Hirosaki University, **57**,25-32.

Byers, R. E., & Carbaugh, D.H. (1995). Chemical, culture and physical factor influencing ‘Stayman’ fruit cracking. Bull. *Virginia Agri. Exp. Stn,* **95**, 1-33.

Chillet, M., & Jannoyer, M. (1996). Choice of bagging for the optimization of banana growth condition Informusa: **5**(1), 25-27.

Cuevas, J., Hueso, J. J., & Martínez, A. (2001). Chemical fruit thinning of loquat by NAAm. Autovía del Mediterráneo, Almería, Spain, **56**, 67-69.

Cuevas, J., Hueso, J. J., & Puertas, M. (2003). Pollination requirements of loquat (*Eriobotrya japonica* L.) cv. ‘Algerie’ Fruits, **58**, 157-165.

Cuevas, J., Aguado, B., & Lorente, N. (1997). Aclareo de estructuras reproductivas en el níspero japonés. *Actas de Horticultura,* **15**, 431-435.

Demir, S. (1987). Loquat Growing. Tarim Orman ve Kyisleri Bakanligi Narenciye Arastirma Enstitu., 12, 30.

Denne, M. P. (1960). The growth of apple fruitlets and the effect of early thinning on fruit development. *Ann Botany,* **24**, 397-406.

Ding, C., Chachin, K., Youshinori, Y., & Wang, C. (2001). Inhibition of Loquat enzymatic browining by Sulfhydyrl compounds. *Journal of Food and Chemistry,* **76**(5), 213-218.

Ding, C. K., Chachin, K., & Ueda, Y. (1997). Effects of polyethylene bag packing and low temperature storage on physical and chemical characteristics of loquat fruit. **34**, 55-56.

Ding, C. K., Hamauzu, Y., Ueda, Y., & Imahori, Y. (1998). Effects of storage temperatures on physiology and quality of loquat fruit. *Postharvest Biology and Technology,* **14**(3), 309-315.

Dong, Li., Zhou, H. W., Sonega, L., Lers, A., & Lurie. S. (2001). Ripening of “Red Rosa” plums: effect of ethylene and 1-methylcyclopropane. Aust. *Journal of Plant Physiology,* **28**, 1039-1045.

Gaol, Z., Nil, Z., Zhang, Z., Gu, L., & Huang, L. (2011). Effects of bagging on sugar metabolism and the activity of sugar metabolism related enzymes during fruit development of Qingzhong loquat. *African Journal of Biotechnology,* **10**(20), 4212-4216.

Gariglio, N., Castillo, A., Juan, M., Lmela, A., & Agusti, M. (2003). Effects of fruit thinning on fruit growth, sugar and purple spot in loquat fruit (*Eriobotrya japonica* L.). *Journal of Horticulture Science Biotechnology,* **78**, 32-34.

Giovannoni, J. (2001). Molecular biology of fruit maturation and ripening. Annual Review. *Plant Physiology and Plant Molecular Biology,* **52**, 725-749.

Grassi, M. A. (2010). Evaluation of thinning intensity on loquat fruit quality. *Bragantia, Campinas,* **60**(1), 215-220.

Garcia, J. M., Ballestros, J. M., & Albi, M. A. (1995). Effect of foliar application of calcium chloride in tomato stored at different temperatures. *Journal of Agriculture and Food Chemistry,* **43**, 9-12.

Gopalkrishna, N., & Deo, P.V. 1960. Role of pouches as banana bunch covers. *Horticulture Abs,* 32p.

Guzman, E. C. (2004). Effect of fruit bagging on sanitation and pigmentation of six mango cultivars. *Acta Horticulture*, **645**, 195–199.

Hans, Y. S. H. (1992). The guide book of food chemical experiments, Pekin Agricultural University Press, Pekin. **12**, 83-91.

Herrera, E. (2002). Improving size and quality of seedless grape. New Mexico State University, Cooperative Extension Service, Guide. 3-11.

Hofman, P. J., Smith, L. G., Joyce, D. C., Jhonson G. I., & Meiburg. G. F. (1977). Bagging of mango (*Mangifera indica*) fruit influences fruit quality and mineral composition. Post harv. *Biotechnolgy,* **12**, 83-91.

Hu, G. B., Chen, D. C., Li, P., Ouyang, R., Gao, F. F.,Wang H. C., & Dong. J. (2001). Effects of bagging on fruit colration and phenylalaine ammonia lyase and polypehnol oxidase in 'Feizixiao'. *Acta Horticulture,* **558**, 273-278.

Huang, C. H., Chai, M. L., Pan, Z. M., Yu, B., Jiang, Z. M., Hu J. L., & Teng, Y. W. (2007). Effects of bagging on fruit skin features and quality of Cuiguan pear cultivar. *Journal of Fruit Science*, **24**, 747-751.

Huang, C., Yua, B., Teng, Y., Sub, J., Shub, O., Chengc Z., & Zeng, L. (2009). Effects of fruit bagging on coloring and related physiology, and qualities of red Chinese sand pears during fruit maturation. *Scientia Horticulturae,* **121**, 149-158.

Huang, G. X., Pan, J. C., He, X. L., Yang X. H., & Lin. S. Q. (2007). A preliminary report of investigation on genus *Eriobotrya* plants in Guangxi and their characteristics. 2nd Int. Symposium on loquat. *Acta Horticulture,* **750**, 101-105.

Hussain, A. (2009). Characterization of loquat genotypes cultivated in Pakistan on the basis of morpho-physical traits and molecular markers. Ph.D. Thesis. Deptt. Hort., PMAS Arid Agri. Univ. Rawalpindi, Pakistan.

Hussain, A., Abbasi, N. A., & Akhtar. A. (2007). Fruit characteristics of different loquat genotypes cultivated in Pakistan. 2nd Int. sympo on loquat. *Acta Horticulture,* **750**, 287-291.

Hussain, A., Abbasi, N. A., Hafiz, I. A., Ahmad Z., & Naqvi. S. M. S. (2009). Molecular characterization and genetic relationship among loquat (*Eriobotrya japonica* L.) genotypes of Pakistan assessed by RAPD markers. *Pakistan Journal of Botany,* **41**, 2437-2444.

Ibrahim, D. & Hamadi. A. (1995). Thinning, harvest and post-harvest operations. *University of Aein Shams, Faculty of Agriculture (Cairo),* **3**, 87-93.

Ibrahim, H. E., Abu-Goukh A. A., & Yusuf, K. S. (1994). Use of ethylene, acetylene and ethereal on banana fruit ripening. *Journal of Agricultural Sciences,* **2**, 73-92.

Ingels, C. (2000). Fruit thinning to increase fruit size. *Cooperative Extension, Uni. California***.** *Publication No,* **31**, 1-2.

Jackson, J. E. (1980). Light interception and utilization by orchard system. *Horticultural Review*, **2**, 208-267.

Jia, H. J., Araki, A., & Okamoto, G. (2005). Influence of fruit bagging on aroma volatiles and skin coloration of 'Hakuho' peach (*Prunus persica* Batsch). *Postharvest Biology and Technology,* **35**, 61-68.

Jonathan, H., Crane, H., & Lilia.C. M. (2006). Loquat Growing in the Florida Home Landscape. **4,** 34-39.

Karadeniz, T. (2002). Loquat (*Eriobotrya japonica* L.) growing in Turkey. Proc. 1st Intl. Symposium on Loquat. Valencia, Spain, 27-28.

Kitagawa, H., Manabe K., & Esguerra, E. B. (1992). Bagging fruit on the tree to control disease. *Acta Horticulre,* **321**, 870-875.

Li, E. M., Shi, D. C., Xu, Y. H., Chen, F., & Zhai, H. (2008). Changing characteristics of temperature and humidity in different type bags for bagging apple and their effects on fruit appearance quality. *Chinese Journal of Applied Ecology,* **19**, 208-212.

Li, J. Q., Hou, C. X., Luo, N., Deng, Q. X., & Wang, Y. Q. 2007. Direct embryogenesis from another culture of loquat. 2nd int. Symposium on loquat. *Acta Horticultre,* **750**, 209-213.

Lin, H. T., Weng, H. L., Zhang, J. N., Liang Y., & Lin, D. C. (2006). Effects of fruit pre-harvest bagging on the quality and post-harvest storability of longan fruit. *Trans. Chin. Soc. Agric. Eng.,* **22**, 232-237.

Lin, S. Q. (2007). World loquat production and research with special reference to China. Proc. 2nd int. Symposium on loquat. *Acta Horticulture,* **750**, 37-44.

Lin, S., Sharpe, R. H. & Janick, J. (1999). Loquat: botany and horticulture. *Horticultural Review,* **23**, 233-276.

Link, H. (2000). Significance of flower and fruit thinning on fruit quality. *Plant Growth Regulation,* **31**, 17-26.

Lu, R. (2004). Multispectral imaging for predicting firmness and soluble solids content of apple fruit. Postharvest Biology and Technology, **31**, 147-157.

Medicott, A. P., & Jeger, M. J. (1987). The development and application of post-harvest treatments to manipulate ripening in the mangoes, In mangoes-A Review. (Eds. R. T. Prinsley, and G. Tucker), London: *Commonwealth Science Council*, 77-83.

McClure, J. (2000). Fruit thinning to increase fruit size. Co-operative Extension, *University of California. Publi. No.*, **31**, 1-2.

McGuire, R. (1992). Reporting of objective color measurements. *Horticultural Sciences*, **27**(12), 1254-1255.

MINFAL. (2009). Agricultural Statistics of Pakistan. Ministry of Food, Agriculture and Livestock. *Economic Wing, Govt. of Pak.*, p.95

Nixon, R. W. (1951). Fruit thinning experiments with medical and Barhae varieties of dates. *Date Grower's Institute Rep.*, **28**, 14-17.

Niu, T. Q., Zhang, H. R., Li M. L., & Hao, Y. Y. (2003). Influences on fruit quality under the microenvironment of bagging and analysis about its mechanism. *Journal of Shangxi Agriculture University*, **23**, 255-259.

Osman, A. M. A., & Abd Elnida, A. H. (1989). Date palm in Kuwait. *Agricultural Extension Department (Alkuwait).* **11**, 113-118.

Pervez, M. A., Tahir, F. M., Ayub C. M., & Cheema, W. A. (1992). physico chemical changes in stored guava fruit as influenced by different wrapping materials. *Journal of Systmetic and Experimental Biology*, **2**(2), 31-37.

Ping, C., Jun, B. L., Li, X. R., & Lu, Z. (2005). The main disease of Chinese loquat cultivars and their integrated control. *South China Fruits*, **3**, 47-50.

Reyes, M. U., & Pauli. R. E. (1995). Effect of storage temperature and ethylene treatments on guava (*Pisidum guajava* L.) fruit ripening. *Postharvest Biology and Technology*, **6**, 357-365.

Rodriguez, A. (1983). El Cultivo del Níspero y el Valle del Algar-Guadalest. Soc. Coop. *de Crédito de Callosa d'Ensarriá, Alicante*, **34**, 4-10.

Solomakhin, A. A. & Blanke, M. M. (2000), Mechanical flower thinning improves the fruit quality of apples. *Wiley Interscience*, 10,10-20p.

Son, I. C., & Lee, C. H. (2008). The effects of bags with different light transmittance on the berry cracking of grape 'Kyoho'. *Horticultural Environmental Biotechnology*, **49**, 98-103.

Song, H. (2002). Thinning flowers and fruits can increase yield. *Hunan Agriculture*, 12, 10.

Studman, C. (1994). Quality in fresh meaning, measurement and maintenance. *XII CIGR. AgEng, Milano*, 897-898.

Uchino, K., Kono, A., Tatsuda Y., & Sakoda, K. (1994). Some factors affecting fruit weight of loquat (*Eriobotrya japonica* L.). *Japan Journal of Tropical Agriculture*, **4**, 286-292.

Vilanova, S., Badenes, M. L., Martinez-Calvo J., & Llacer, G. (2001). Analysis of loquat germplasm by RADP molecular markers. *Euphytica*, **121**, 25-29.

Wade, N. L., Kavanagh E. E., & Jan. S. C. (1973). Sunscald and ultra-violet light injury of banana fruits. *Journal of Horticultural Sciences*, **68**(3), 409-419.

Wang, L., Xu, K., Bei, F., & Gao, F. S. (2007). Effects of bagging on the microenvironment, yield and quality of over-wintering tomato. *Chinse Journal of Applied Ecology*, **18**(4), 837-842.

Watada, A. E. (1987). Postharvest physiology of vegetables. *In J. Weichmann (Ed.), New York: Dekker*, 12-19

Weerasinghe, S. S. (2000). Influence of high density planting on the productivity of banana *(Musa ssp)* under irrigated conditions. *Annual Symposium of the Department of Agri. Sri Lanka*, **2**, 319-324.

Wertheim, S. J. (2000). Developments in the chemical thinning of apple and pear. *Plant Growth Regulators.*, **31**, 85-100.

Wertheim, S. J., Nijsse F., & Joosse. M. L. (1977). Benoni telen zonder doorplucken beurtjaren. *Fruit teelt* **67**, 475-478.

Wu, W., Lu, Z., Zhang, Z., Li, M., Cao X., & Cao, Z. (2004). The effect on Loquat fruit growth and quality by flower and fruit thinning and bagging. *Northwest A. & F. Univ. Natural Science Version*. **32**, 73-75.

Xu, H., Chenand, J. & Xie. M. (2010). Effect of different light transmittance paper bags on fruit quality and antioxidant capacity in loquat. *Journal of Science and Food Agriculture*, **90**, 1783-1788.

Yang, W. H., Zhu, X. C., Bu, J. H., Hu, G. B., Wang, H. C., & Huang. X. M. (2009). Effects of bagging on fruit development and quality incross-winter off-season longan. *Scientia Horticultrae*, **120**, 194-200.

Zheng, S. Q. (2007). Achievement and prospect of loquat breeding in China. 2nd Int. Sympo. On Loquat. *Acta Horticulture*, **750**, 85-91.