

Short Communication

Response to γ radiation and storage temperature on quarantine pests of alphonso mango

M. K. Yadav* and B. R. Parmar

Department of Horticulture, N. M. College of Agriculture, Navsari Agricultural University, Dandi Road, Navsari-396450, India.

Received 25 April, 2014; Accepted 2 June, 2014

Application of food irradiation for sanitary and phytosanitary purposes to ensure food safety and quality and facilitate international trade, including quarantine measures related to fresh products. The irradiation technique is now emerging as a demanding tool for controlling insect-pests. This technique has been a successful tool against a number of pest species. In this regard, the study was conducted to evaluate four (0.00, 0.20, 0.40 and 0.60 kGy) gamma irradiation doses and similar storage temperature (Ambient, 9 and 12°C and CA storage at 12°C) against the quarantine pests of alphonso mango fruit. The fruits were exposed to gamma radiation for different doses from the source of ^{60}Co . The two year studies revealed that there were no stone weevil and fruit fly incidence in any treatment (gamma irradiation or storage temperature) during study, except unirradiated fruits stored at ambient temperature; recorded fruit fly infestation.

Key words: Fruit fly, gamma irradiation, quarantine pests, stone weevil, storage temperature.

INTRODUCTION

Mangoes (*Mangifera indica* L.; family Anacardiaceae) are in over 90 countries worldwide. Asia accounts for 77% of global mango production and the Americas and Africa account for 13 and 19%, respectively (Pereira et al., 2010). It has been a long journey, both for food irradiation research and development as well as the emperor of fruits, the Indian mango, to make it to one of the world's most wanted markets, the USA. India is the global leader in mango production and it is also one of the most important tropical fruit of Asia with a high demand in the world market (Tharanathan et al., 2006). International trade, particularly of mango, is subjected to quarantine

regulations in most of the importing countries because of the presence of fruit flies (*Bactrocera dorsalis*, Hendel) and stone weevil (*Stenochetus mangiferae*) in India. United States, Japan, Australia and New Zealand have previously prohibited import of mango from India. Current official quarantine procedures used for treating fruits and plant materials for export markets are vapour heat treatment, chemical fumigation with ethylene dibromide or methyl bromide or combinations of fumigation and cold treatment (Thomas, 1993). However, none of these treatments are effective against the mango stone weevil. The use of ethylene dibromide for quarantine fumigation

*Corresponding author. E-mail: manoj_kadali11@hotmail.com, Tel: +91 9377310884.

Author(s) agree that this article remain permanently open access under the terms of the [Creative Commons Attribution License 4.0 International License](https://creativecommons.org/licenses/by/4.0/)

of fruits is banned in USA because of the evidences of its carcinogenic and mutagenic effects in test animals. Methyl bromide has phytotoxic effect on many fruits.

The usefulness of gamma irradiation as an alternative to chemical fumigation has been demonstrated against both fruit flies and mango stone weevil. Since the weevil develops and completes its life cycle inside the mango seed, conventional, chemical or physical treatments are not effective against this insect. Irradiations was also found to inhibit the development stages of mango fruit fly and the melon fly (*Dacus cucurbitae*, coquillot) commonly found infesting mango. Irradiation disinfestations of mangoes were found to be superior to more conventional methods of disinfestations, such as ethylene dibromide fumigation or vapour heat treatment (Yadav et al., 2013). Irradiations are a physical process for the treatment of foods akin to conventional process like heating or freezing. It prevents food poisoning, reduces wastage to contamination and at the same time preserves quality (Mahindru, 2009). The issues related to quarantine and phytosanitary are the major stumbling blocks to trade, both national and international (Yadav et al., 2010). Therefore, the study conducted for find out the balance between required effective dose and tolerance of fruit to irradiation under various storage temperatures.

MATERIALS AND METHODS

Material and preparation

The export grade mangoes of cv. Alphonso were harvested from orchard of Navsari Agricultural University, Navsari, Gujarat, India. The selected mangoes from Class I as per the quality parameters specified and described in "post harvest manual for mangoes" published by Agricultural Production and Export Development Authority (Anonymous, 2007). These were sorted for uniformity in size, maturity and freedom from defects. The fruits were kept in plastic crates with cushioned material and transported to cold storage, Post Harvest Technology Unit of ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari (Gujarat) India. Than after, fruits were again sorted to remove those with spotty and having bad appearance. The individual fruit weight was from 250 to 350 g. The selected fruits wash with chlorine water and after drying fruits packed in corrugated fibre board (CFB) boxes cushioned with tissue paper. The dimensions of CFB box were 370 × 275 × 90 mm and gross weight of box with fruits was 3.0 kg. One CFB box having nine fruits for each treatment, each treatment replicated thrice. The packed boxes kept in cold storage at 12°C for 8 h for pre-cooling treatment. The time gap between harvesting and pre-cooling was not more than 6 h.

Radiation treatment

After pre-cooling, fruits transport to irradiation treatment in air conditioned vehicle. It was carried out at ISOMED plant, Board of Radiation and Isotope Technology, Sir Bhabha Atomic Research Centre, Mumbai, India. The fruits were exposed to gamma radiation for different doses from the source radio isotope ^{60}Co with energy 1.33 MeV. The source rack with its ^{60}Co pencils was raised from the storage pool by automated control system. The product packages are then moved around the radiation source in such a way that they

are exposed to radiation for predefined time. There were four irradiation doses that is, I₁ -0.00 kGy (Unirradiated), I₂ -0.20kGy, I₃ -0.40kGy and I₄ -0.60kGy. The time gap between pre-cooling and irradiation was not more than 9 h. After irradiation, fruits immediately transported to cold storage of university in air conditioned vehicle.

Storage conditions

The CFB boxes were kept in cold storage at different temperature as per storage temperature treatments. The treatments are S₁- Ambient (27±2°C, 60-70% RH, S₂-9°C, 90% RH, S₃-12°C, 90% RH and S₄- Control atmospheric storage (12°C, O₂ 2%, CO₂ 3% and RH 90%). The infestation of fruit fly and stone weevil were studied.

Measurement protocols for incidence of fruit fly and stone weevil

The fruits cut with the help of sharp knife and visually observed the larvae of the fruit fly at the end of storage. The number of fruit fly attacked fruits were counted and expressed as percentage. For stone weevil, stone of fruits cut with the help of sharp knife and visually observed the stone weevil at the end of storage. The number of stone weevil attacked fruits were counted and expressed as percentage.

Data analysis

Two years data obtained from experiment was statistically analyzed using ANOVA for completely randomizes design with factorial concept. Significance differences among treatments were compared using the Fisher's analysis of variance at the 5% probability level, technique as given by Panse and Sukhatme (1967). The data were subjected to appropriate transformation (arcsine) when necessary to meet the assumptions of normality.

RESULTS AND DISCUSSION

The fruit fly incidence was significantly influenced by the irradiation and storage temperature individually as well as in interaction (Table 1). It can be seen from the data there was no fruit fly incidence in fruits exposed to gamma rays. Fruits stored at 9 and 12°C and in CA (12°C) storage also showed no fruit fly incidence. Only unirradiated ambient stored fruits showed 9.28% fruit fly incidence. The irradiated fruits stored at ambient temperature as well as the unirradiated fruits stored at 9 and 12°C and in CA (12°C) storage showed fruit fly free fruits might be due to sensitivity of the insects to irradiation, the sensitivity being directly proportional to reproductive activity and inversely proportional to the degree of differentiation. Thus, irradiation had lethal effect on dividing cells during embryonic development in eggs. Therefore irradiated fruits had less infestation compared to unirradiated fruits (Udipi and Ghugre, 2010). Similar results also observed by Manoto et al. (1987) and Srivastava (1997) in mango; Singh and Pal (2007) in guava and Rivera and Hallman (2007) in papaya. In conclusion view of point the fruit fly incidence was not

Table 1. Response to irradiation and storage temperature against mango fruit fly (*Bactrocera dorsalis*, Hendel) and stone weevil (*Stenochetus mangiferae*) percent.

Fruit fly (<i>Bactrocera dorsalis</i> , Hendel)																
Source	I year					II year					Mean					
	I ₁	I ₂	I ₃	I ₄	Mean	I ₁	I ₂	I ₃	I ₄	Mean	I ₁	I ₂	I ₃	I ₄	Mean	
S ₁	0.00	0.00	0.00	0.00	0.00	10.12 (18.55)	0.00 (1.65)	0.00 (1.65)	0.00 (1.65)	0.00 (1.65)	2.5 (6.64)	9.28 (5.60)	0.00 (0.82)	0.00 (0.82)	0.00 (0.82)	2.94 (2.02)
S ₂	0.00	0.00	0.00	0.00	0.00	0.00 (1.65)	0.00 (1.65)	0.00 (1.65)	0.00 (1.65)	0.00 (1.65)	0.00 (1.65)	0.00 (0.82)	0.00 (0.82)	0.00 (0.82)	0.00 (0.82)	0.00 (0.82)
S ₃	0.00	0.00	0.00	0.00	0.00	0.00 (1.65)	0.00 (1.65)	0.00 (1.65)	0.00 (1.65)	0.00 (1.65)	0.00 (1.65)	0.00 (0.82)	0.00 (0.82)	0.00 (0.82)	0.00 (0.82)	0.00 (0.82)
S ₄	0.00	0.00	0.00	0.00	0.00	0.00 (1.65)	0.00 (1.65)	0.00 (1.65)	0.00 (1.65)	0.00 (1.65)	0.00 (1.65)	0.00 (0.82)	0.00 (0.82)	0.00 (0.82)	0.00 (0.82)	0.00 (0.82)
Mean	0.00	0.00	0.00	0.00	0.00	2.53 (6.64)	0.00 (1.65)	0.00 (1.65)	0.00 (1.65)	0.00 (1.65)	2.94 (2.02)	0.00 (0.82)	0.00 (0.82)	0.00 (0.82)	0.00 (0.82)	0.00 (0.82)
Source		I	S	I X S		I	S	I X S		I	S	I X S		I	S	I X S
S. Em ±		-	-	-		0.001	0.001	0.002		0.001	0.001	0.002		0.001	0.001	0.012
CD (P≤0.05)		-	-	-		0.003	0.003	0.006		0.003	0.003	0.006		0.003	0.003	0.036

N.B.: There was no incidence of stone weevil (*Stenochetus mangiferae*) in both years. Figure in parenthesis indicates ARC SINE transformed value Where I = irradiation, S = Storage temperature, CA = Control atmospheric storage.

observed in the fruits subjected to gamma irradiation whereas; 9.28% was observed in fruits which was kept without irradiation. No fruits were found with stone weevil infestation.

Conflict of Interests

The author(s) have not declared any conflict of interests.

ACKNOWLEDGEMENTS

Thanks are due to Dr. R. Chander, Dr. L. N. Bandi, Dr. A. Shrivastva and Shri Jyotis, Board of Radiation and Isotope Technology, BARC, Mumbai and Dr. N. L. Patel, Dean, ACHF, NAU, Navsari (India).

REFERENCES

Anonymous (2007). Post harvest manual for mangoes. Agricultural Production and Export Development

- Authority, Ministry of Agriculture. Government of India.
 Mahindru SN (2009). Food preservation and irradiation. APH publishing corporation, New Delhi.
 Manoto EC, Rosario MS, Del-Rosario, MS (1987). Mango disinfestation strategies in relation to quarantine requirements in the Philippines. In: Plant quarantine and phytosanitary Barriers to trade in the ASEAN, 9-10 Dec, pp. 193-207.
 Panse VG, Sukhatme PV (1967). Statistical Methods for Agricultural workers, ICAR, New Delhi.
 Pereira T, Tijskens, LMM, Vanoli M, Rizzolo A, Eccherzberini P, Torricelli A, Spinelli L, Filgueiras H (2010). Assessing the harvest maturity of Brazilian mangoes. EW Hevett et al.(Ed..) ,Proc IS on Post Harvest Pacifica 2009. Acta Hort. 880.
 Rivera ZT, Hallman GJ (2007). Low dose irradiation phytosanitary treatment against. *Mediterranean* fruit fly (Diptera: Tephritidae). Florida Entomol. 90(2):343-346. [http://dx.doi.org/10.1653/0015-4040\(2007\)90\[343:LIPTAM\]2.0.CO;2](http://dx.doi.org/10.1653/0015-4040(2007)90[343:LIPTAM]2.0.CO;2)
 Singh SP, Pal PK (2007). Post harvest fruit fly disinfestation strategies in rainy season guava crop. Acta Hort. 375:591-596.
 Srivastava RP (1997). Mango quarantine pests export and rules. International Book Distributing Co, Lucknow, India.
 Tharanathan RN, Yashoda HM, Prabha TN (2006). Mango (*Mangifera indica* L), 'the king of fruits' – An overview. Food Rev. Int. 22:95-123. <http://dx.doi.org/10.1080/87559120600574493>

- Thomas P (1993). Irradiation of foods. In: Chadha, KL and Pareek OP (Eds.). Advances in Horticulture, Malhotra Publishing House, New Delhi. pp. 1810-1835.
 Udipi SA, Ghurge PS (2010). Applications of food irradiation. In: Udipi, SA and Ghurge PS (Eds.), Food irradiation, Agrotech Publishing academy, Udaipur. pp. 40-71.
 Yadav MK, Patel NL, Hazarika A, Chaudhary PM (2010). Physiological changes in Kesar mango as influenced by treatment and storage. Hort. J. 23(1):16-17.
 Yadav MK, Patel NL, Parmar BR, Nayak D (2013). Evaluation of physiological and sensory changes of kesar mango (*Mangifera indica* L.) influenced by ionizing radiation and storage temperature. SAARC Agric. J. 1(2):69-80.