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# RESPONSE TO GAMMA RADIATION AND STORAGE TEMPERATURE ON QUARANTINE PESTS OF ALPHONSO MANGO

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## ABSTRACT

Application of food irradiation for sanitary and phytosanitary purposes to ensure food safety and quality and to facilitate international trade, including quarantine measures related to fresh products are of paramount importance. 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 0.60kGy) gamma irradiation doses and similar storage temperature (Ambient, $9^0$C, $12^0$C and CA storage at $12^0$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 was 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

Mango (*Mangifera indica* L.; family Anacardiacae) is grown in over 90 countries. 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 (*Strenochetus mangiferae*) in India. United States, Japan, Australia and New Zealand have previously prohibited import of mango from India. USA import only irradiated mango and from last few years, US started importing Indian mango after 18 years, under the quarantine conditions. 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. However, none of these treatments are effective against the mango stone weevil. The use of ethylene dibromide for quarantine fumigation 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. Irradiation 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 (Udipi and Ghurge, 2010). 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. Therefore, a balance between the required effective dose and tolerance of fruit to irradiation has to be investigated under various storage temperatures.

## MATERIAL 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 (Anon., 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. Thereafter, fruits were again sorted to remove those with spots and having bad appearance. The individual fruit weight ranged from 250-350g. The selected fruits were washed 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 X 275 X 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 were kept in cold storage at 12°C for 8 hours for pre-cooling treatment. The time gap between harvesting and pre-cooling was not more than 6 hours.

**Radiation treatment:** After pre-cooling, fruits were transported 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 1.33MeV. The source rack with its $^{60}$Co pencils was raised from the storage pool by automated control system. The product packages were then moved around the radiation source in such a way that they were exposed to radiation for predefined time. There were four irradiation doses *i. e.* $I_1$ -0.00kGy (Unirradiated), $I_2$ -0.20kGy, $I_3$ -0.40kGy and $I_4$ -0.60kGy. The time gap between pre-cooling and irradiation was not more than 9 hours. After irradiation, fruits were 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 $S_1$-Ambient (27±2°C, 60-70% RH, $S_2$-9°C, 90% RH, $S_3$-12°C, 90% RH and $S_4$-Control atmospheric storage (12°C, $O_2$ 2%, $CO_2$ 3% and RH 90%). The infestation of fruit fly and stone weevil were recorded.

**Measurement protocols for incidence of fruit fly and stone weevil:** The Fruits were cut with the help of sharp knife and visually observed for larvae of the fruit fly at the end of storage. The number of fruit fly attacked fruits was counted and expressed as percentage. For stone weevil, stone of fruits were cut with the help of sharp knife and visually observed for 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 randomized 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 °C, 12 °C and in CA (12 °C) storage also showed no fruit fly incidence. Only unirradiated ambient stored fruits showed 9.28 per cent fruit fly incidence. The irradiated fruits stored at ambient temperature as well as the unirradiated fruits stored at 9 °C, 12 °C and in CA (12 °C) storage showed fruit fly free fruits that could 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. Similar results were also observed by Manoto *et al*. (1986) and Srivastava (1997) in mango; Singh and Pal (2007) in guava and Rivera and Hallman (2007) in papaya. In concluding view of point the fruit fly incidence was not observed in the fruits subjected to gamma irradiation; whereas, it was observed nearly 9 per cent fruits when kept without irradiation. No fruits were found with stone weevil infestation.

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**Table 2. Response to irradiation and storage temperature against mango fruit fly (*Bactrocera dorsalis*, Hendel) and stone weevil (*Strenochetus mangiferae*) per cent**

| | Fruit fly (*Bactrocera dorsalis*, Hendel) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I year | | | | | II year | | | | | Mean | | | | |
| Source | $I_1$ | $I_2$ | $I_3$ | $I_4$ | 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 | 0.00 | 0.00 | 0.00 | 2.5 | 9.28 | 0.00 | 0.00 | 0.00 | 2.94 |
| | | | | | | (18.55) | (1.65) | (1.65) | (1.65) | (6.64) | (5.60) | (0.82) | (0.82) | (0.82) | (2.02) |
| **$S_2$** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | | | | | (1.65) | (1.65) | (1.65) | (1.65) | (1.65) | (0.82) | (0.82) | (0.82) | (0.82) | (0.82) |
| **$S_3$** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | | | | | (1.65) | (1.65) | (1.65) | (1.65) | (1.65) | (0.82) | (0.82) | (0.82) | (0.82) | (0.82) |
| **$S_4$** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | | | | | | (1.65) | (1.65) | (1.65) | (1.65) | (1.65) | (0.82) | (0.82) | (0.82) | (0.82) | (0.82) |
| **Mean** | 0.00 | 0.00 | 0.00 | 0.00 | | 2.53 | 0.00 | 0.00 | | 0.00 | 2.94 | 0.00 | 0.00 | 0.00 | |
| | | | | | | (6.64) | (1.65) | (1.65) | | (1.65) | (2.02) | (0.82) | (0.82) | (0.82) | |
| Source | 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 | | 0.012 |
| CD (*P*=0.05) | - | | - | | - | 0.003 | | 0.003 | | 0.006 | 0.003 | | 0.003 | | 0.036 |

N.B.: There was no incidence of stone weevil (*Strenochetus mangiferae*) in both the years, Figure in parenthesis indicates arc sine transformed value

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