Short Communication

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Ramification of post-harvest thermal disinfestation technology for mango fruit flies [*Bactrocera* spp. (Diptera: Tephritidae)] across India

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Mango (*Mangifera indica*) is the most important fruit crop of India with high potential in export and foreign exchange. An impediment in mango fruits export has been the infestation by *Bactrocera dorsalis* (Hendel) and *B. zonata* (Saunders). The adoption of pre-harvest Integrated Pest Management (IPM) developed by ICAR-Indian Institute of Horticultural Research (IIHR) reduced infestation by 95% (Stonehouse *et al*., 2005, Verghese *et al*., 2002). Subsequent improvement of pre-harvest control using ovipositional deterrence gave more than 98% control (Verghese *et al*., 2020). However, for exports, 100% disinfestation is mandatory. For the most part, postharvest pest control is focused on trade and exports. In order to achieve safe post-harvest disinfestation several experiments and studies were conducted on main commercial varieties using hot water (45°C to 48°C), for different lengths of time to standardize the thermal disinfestation protocol which is internationally acceptable (Yahia and Campos, 20.

All the studies were conducted at ICAR-IIHR where orchards of major export mango varieties are available. The entomology division here has an excellent fruit fly breeding laboratory and cultures. The Institute also built a prototype of the thermal disinfestation tank (Fig. 1) which all helped in developing a thermal disinfestation technology by 2011 (Verghese *et al*., 2011). This was adopted by Directorate of Plant Protection, Quarantine and Storage (DPPQS) and included under National Standards and Phytosanitary Measures (NSPM-15) on guidelines for certification of Hot Water Immersion Treatment (thermal disinfestation) facilities for mango fruits (DPPPQS, 2023).

During 2011 only two facilities had registered and established. However, during 2014 the European Union (EU) banned import of mangoes from India because of fruit fly infestation (PIB, GoI, 2015). This prompted the establishment of 11 thermal disinfestation facilitates in 2015 by DPPQS[6]. After this there was a steady increase in the establishment of thermal disinfestation facilitates from 13 to 52 as of 2023 (Fig. 1 and 4; Table 1). On 12th February 2015 EU lifted the ban on mango imports and till today there has been no reports of fruit fly infestation in the mango consignments (PIB, GoI, 2015).

The thermal disinfestation technology was a culmination of researches in varietal selection, insect behavioral studies, mortality assessment due to hot water on eggs and first instar larvae, standardizing of thermal tank with appropriate thermostat and post-harvest organoleptic tests (Verghese *et al*., 2011, Verghese and Rashmi, 2014).

Further the protocol consisted of a thermostat-controlled metal hot water bath (Fig. 2), the size of which can vary with volume of fruits, in which fruits harvested are submerged at 48°C (maintained thermostatically) (Fig. 3), for 60 to 75 minutes (depending on size and variety of mango) to disinfest eggs and 1st instar of fruit flies which are not easily discernable at harvest. The prototype was suitably scaled up by DPPQS to treat large volumes of mangoes where baskets of freshly harvested fruits are lowered into the hot water bath. The fruits are held at the prescribed temperature and length of time, then taken out, by an overhead hoist. The technology has ramified to 52 registered thermal water treatment plants in India (Fig. 4) (DPPPQS, 2023). Today this technology has helped in exporting mango varieties to countries where thermal disinfestation is mandatory: all European Union countries, Switzerland, Iran, South Korea and Mauritius (APEDA, 2023). India has exported 22963.76 MT of fresh mangoes worth of Rs. 378.49 crores/ 48.53 USD millions during the year 2022-23 (APEDA, 2023).

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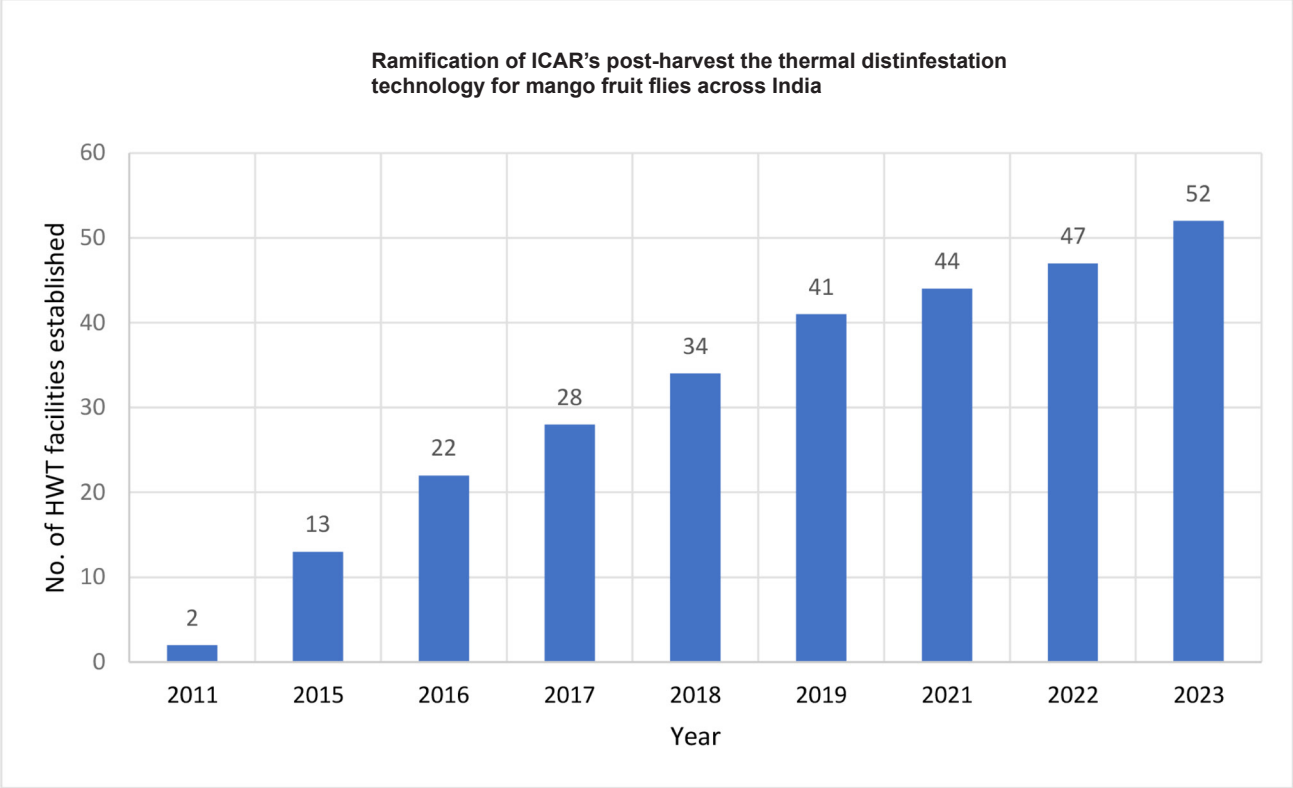

Fig. 1: Number of post-harvest thermal disinfestation technology across India from 2011 to 2023 (*Source:* DPPQS, GoI).

Fig. 2: Prototype of thermal disinfestation treatment developed at ICAR-IIHR during 2011 (In picture Dr. Amrik Singh Sidhu the then Director ICAR-IIHR with Dr Abraham Verghese)

Fig. 3: Thermal disinfestation immersion treatment process at a registered facility

Fig. 4: Map showing registered thermal disinfestation treatment facilities in India [6](as per NSPM – 15) https://pqms.cgg.gov.in/c5c4e81d-1670-4135-b66f-4ace5aed276f

It is interesting to note that these thermal water plants are concentrated around major mango marketing belts of India, 18 facilities in Maharashtra, 14 in Gujarat followed by other states as given in Table 1 (DPPPQS, 2023). These facilities are accredited by DPPQS and Agriculture Products Export Development Authority (APEDA). Export farmers can make use of these facilities after following the required formalities. The scope for enhancing exports is dependent on further ramification of the technology.

Table.1: Spread of the post-harvest thermal disinfestation technology across different states in India up to 2023 (*Source:* DPPQS, GoI, 2023).

State	No. of thermal disinfestation facilities
Maharashtra	18
Gujarat	14
Karnataka	5
Uttar Pradesh	4
West Bengal	3
Andhra Pradesh	2
Tamil Nadu	2
Telangana	2
Delhi	1
Kerala	1
Punjab	1
Total	**52**

The ramification of a single technology to 52 centers across different states of the country (Table 1) is a success story of interdisciplinary sciences leading to an adoptable viable technology especially because it has boosted exports, commerce and higher income to farmers (APEDA, 2023) and has provided environment-friendly and residue-free fruits (Verghese and Rashmi, 2014). Many other such ICAR technologies and varieties developed have helped the growth of agriculture and economy in India (ICAR, 2023).

Therefore, translating knowledge and research into adoptable technologies only will serve to contribute to the country's horticultural and economic growth.

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References

Guidelines for Certification of Hot Water Immersion Treatment Facilities for Mango Fruits, NSPM 15, Government of India Ministry of Agriculture Department of Agriculture & Cooperation Directorate of Plant Protection, Quarantine & Storage Faridabad https://www.pqismoa.nic.in/PQISPub/pdffiles/NSPM15%20Guidelines%20for%20Certification%20of%20HWT.pdf (Accessed 8 July 2023).

Indian Council of Agricultural Research (ICAR), Technologies & Products for Commercialization https://icar.org.in/technologies-products-commercialization (Accessed 20 October 2023).

Press Information Bureau, Government of India, Ministry of Commerce & Industry https://pib.gov.in/newsite/PrintRelease.aspx?relid=116998#:~:text=FVO%20Mission%20have%20given%20affirmative,2015 (Accessed 20 October 2023).

Stonehouse J M, Verghese A, Mumford J D, Thomas J, Jiji T, Faleiro R, Patel Z P, Jhala R C., Patel, Shukla R. K. R. P, Satpathy S, Singh H.S, Singh A. and Sardana HR, 2005. Research conclusions and recommendations for the on– farm IPM of Tephritid fruit flies in India, *Pest Manage. Hortic. Ecosys.* ***11***(2): 172-180.

The Agricultural and Processed Food Products Export Development Authority (APEDA) https://apeda.gov.in/apedawebsite/SubHead_Products/Mango.htm (Accessed 12 July 2023)

Verghese A, Madhura H S, Jayanthi P D K and Stonehouse J M, 2002. Fruit flies of economic significance in India, with special reference to *Bactrocera dorsalis* (Hendel). *Proceedings of 6th International Fruit fly Symposium* held between 6–10 May 2002, Stellenbosch, South Africa. pp. 317 – 324.

Verghese A, Nagaraju D K. and Sreedevi K, 2011. Hot water as an effective postharvest disinfection for the oriental fruit fly, *Bactrocera dorsalis* (Hendel) on mango. *Pest Manage. Hortic. Ecosys.* ***17***(2): 63-68.

Verghese A, Rakshitha M, Shivananda T N, Soumya C. B. and Rashmi. M.A., 2020. A push-pull strategy for the management of the Oriental fruit fly, *Bactrocera dorsalis* (Hendel) in mango. *Pest Manage. Hortic. Ecosys.* ***26***(2):269-271.

Verghese A. and Rashmi M A, 2014. Insect Disinfection and Quarantine. In *Managing post-harvest quality and losses in horticultural crops.* (Eds. Chadha KL and Pal RK) Daya Publishing House® A Division of Astral International Pvt. Ltd. New Delhi-110 002, India. ISBN 978-93-5461-960-1 (HB) pp.211 -230.

Yahia, E M. and J P. Campos. 2000.The effect of hot water treatment used for insect control on the ripening and quality of mango fruit. *Acta Horticulturae*. **509**: 495-501.