frontiers | Frontiers in Agronomy

TYPE Editorial
PUBLISHED 10 April 2024
DOI 10.3389/fagro.2024.1407495

OPEN ACCESS

EDITED AND REVIEWED BY
Murray B. Isman,
University of British Columbia, Canada

*CORRESPONDENCE
Anamika Sharma
anamika.sharma@famu.edu

RECEIVED 26 March 2024
ACCEPTED 01 April 2024
PUBLISHED 10 April 2024

CITATION
Muniappan R, Ba M, Sharma A and Hendery S (2024) Editorial: Integrated Pest Management of tropical crops.
Front. Agron. 6:1407495.
doi: 10.3389/fagro.2024.1407495

Editorial: Integrated Pest Management of tropical crops

Rangaswamy Muniappan[1], Malick Ba[2], Anamika Sharma[3]* and Sara Hendery[1]

[1]Center for International Research, Education and Development, Virginia Tech, Blacksburg, VA, United States, [2]Regional Office, World Vegetable Center (Benin), Cotonou, Benin, [3]Center for Biological Control, College of Agriculture and Food Sciences, Florida A&M University, Tallahassee, FL, United States

KEYWORDS

Integrated Pest Management (IPM), cacao, insect pests, plant pathogens, tropical crops

Editorial on the Research Topic
Integrated Pest Management of tropical crops

Over half a century ago, the concept of Integrated Pest Management (IPM) was developed by entomologists at the University of California at Berkeley. The idea centered around the economic, social, and environmental ramifications of the indiscriminate use of chemical pesticides – including pest resistance, resurgence of pests, and adverse impacts on non-target species, humans, wildlife, and the environment (Stern et al., 1959). FAO (1994) has defined the concept as "the careful integration of several available pest control techniques that discourage pest population development and keep pesticide and other interventions to levels that are economically justified and safe for human health and the environment." IPM is a dynamic program specific to crop, location, season, and economic conditions, including political, that combines all available tactics to help grow healthy plants (Muniappan et al., 2016). It combines cultural control, mechanical control, host plant resistance, biological control, and chemical control with safe insecticides, while involving the disciplines of entomology, plant pathology, nematology, weed science, economics, sociology, computer sciences, statistics, and others.

IPM is targeted for a crop or a weed (especially for alien invasive ones) and not for addressing a single insect pest, disease, or nematode. Even though IPM began to reduce reliance on chemical pesticides by involving biological control and host plant resistance, it is an agroecological approach to pest and disease management (Pretty et al., 2010). In some cases, a single component of IPM, classical biological control, has suppressed pests such as papaya mealybug, *Paracoccus marginatus* Williams and Granara de Willink (Hemiptera: Pseudococcidae) (Myrick et al., 2014), cassava mealybug, *Phenococcus manihoti* Matile-Ferrero (Hemiptera: Pseudococcidae) (Neuenschwander, 2003), and cassava green mite, *Mononychellus tanajoa* Bondar (Acari: Tetranychidae) (Yaninek and Hanna, 2003), but such a solution needs to be integrated with the IPM packages of the crops these pests are associated with. While IPM does not represent the management of a single group of arthropods or diseases, IPM research has been dominated by an insect bias, followed by diseases, then weeds (Pretty et al., 2010, Muniappan et al., 2016).

Since IPM tactics vary from location to location and season to season, they cannot be proposed as a blanket recommendation (Dilts and Hale, 1996) and they need to be modified and adjusted accordingly. The popular extension program of the 1960s, "Training and Visit (T&V)," did not prove effective in transferring IPM technologies to developing countries (Matteson, 2000). The attempted transfer of IPM technologies – similar to the technology packages developed amid the "green revolution" paradigm, with input-intensive, high-yielding varieties, chemical fertilizers, and pesticides – in developing countries needed modification to be adopted (Shepard et al., 2009). However, in the late 1980s, FAO introduced the Farmer Field School program based on participatory learning introduced in Indonesia and other Asian and African countries (Braun et al., 2000) but it proved not to be cost-effective (Feder et al., 2004).

Technologies produced in developed countries require modification and validation before widespread introduction in developing countries, as there are marked differences in climate, farm holdings, farming practices, knowledge level, economics, policies, and biodiversity. Educating scientists, extension agents, NGOs, and value chain actors in developing countries is essential for training farmers (Parsa et al., 2014). Often, the recommended technology fails to be adopted when the product involved is not available or readily accessible to a farmer's dwelling. For example, when the IPM Innovation Lab, a USAID-funded project, introduced to Nepal *Trichoderma* sp., a technology that controls soil-borne fungal diseases, it became apparent that information dissemination about the technology to farmers alone did not result in transformation. Adoption of the technology required collaborating with local entrepreneurs in the production of *Trichoderma*, educating agricultural input dealers on its benefits, and making the product available in the nearby markets (Muniappan et al., 2016).

Hokkanen (2015) described the initial development of IPM by a model, placing IPM principles of landscape management, cultural control, host plant resistance, conservation of natural enemies, and biological control at the bottom of the pyramid, and pesticide resistance management at the top. However, developments in the past half a century have inverted this model by placing pesticide resistance management at the base and other IPM principles on the top in developed countries. Developing countries are still in the initial pyramidal model stage, which is important to maintain, so as not to let these regions fall to the fate of developed countries.

The IPM Innovation Lab has developed IPM packages for several tropical crops (Muniappan et al., 2021) with an emphasis on tackling pest problems encountered from the time of planting to the harvest of the crop. However, the components in these packages need to be modified to the local conditions, needs, and accessibility. Some of the components include incorporating *Trichoderma* sp. in compost or treating seeds with *Trichoderma* sp., which protects the seedlings from soil-borne fungal diseases; using cocopith, a biproduct of the coconut, which can be used in the tropics for raising seedlings as an alternate product for peat moss; culling diseased seedlings in the nursery stage before transplanting; use of pheromone traps for monitoring pests and taking timely interventions; augmentative release of biocontrol agents; observing conservation biological control; incorporation of microbial and botanical pesticides; and judicious use of chemical pesticides when needed.

As Ricker-Gilbert et al. (2008) pointed out, simpler practices may be adopted faster than more complex ones. It is common that not all the components recommended in an IPM package for a crop are adopted by all farmers, especially in the early stages. The adoption rate increases over time. There are probably only a few crop ecosystems and pest complexes that can justify or would require the application of the total spectrum of pest management strategies and tactics (Apple and Smith, 1976). Partial adoption of IPM does not make it a poor investment (Norton et al., 2019).

The articles included in this Research Topic focus on tropical crops, including cowpea (*Vigna unguiculata*) in West Africa, African eggplant (*Solanum aethiopicum*) in Uganda and Tanzania, and Cacao (*Theobroma cacao*) in the Philippines. Included articles are reviews and research articles. Research articles have focused on cultural (pheromone) and biological control strategies (entomopathogenic fungus).

Togola et al. review the progress made in managing cowpea insect pests in Africa, Xu et al. report identification of the causative organism of wilt disease of the African eggplant, and the following three articles cover management of cacao pest in the Philippines. Amalin et al. present their field study on evaluation of sex pheromone of cacao pod borer, *Conophomorpha cramerella* Snellen (Lepidoptera: Gracillariidae), Tavera et al. on identification of β-Caryophyllene as an attractant for the cacao mirid bug, *Helopeltis bakeri* Poppius (Hemiptera: Miridae), and clay particles as carrier of entomopathogenic agents of *H. bakeri*. These articles contribute to growing information around IPM components of these three valuable tropical crops.

Author contributions

RM: Writing – original draft. MB: Writing – review & editing. AS: Writing – review & editing. SH: Writing – review & editing.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. This research benefited from USAID Cooperative Agreement No. AID-OAA-L-15-00001 Feed the Future Innovation Lab for Integrated Pest Management (IPM IL), and the USAID Bangladesh Mission Associate Award No. 72038821LA00001.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

Apple, J. L., and Smith, R. F. (1976). "Progress, problems, and prospects for integrated pest management," in *Integrated Pest Management*. Eds. L. A. Apple and R. F. Smith (Integrated Pest Management. Plenum Press, New York), 179–196. doi: 10.1007/978-1-4615-7269-5

Braun, A. R., Thiele, G., and Fernández, M. (2000). Farmers field schools and local agricultural research committees: complementary platforms for integrated decision-making in sustainable agriculture. *Agricultural Research & Extension Network (AgREN)*. Network Paper No. 105, 1–21.

Dilts, D., and Hale, S. (1996). *Farmer field school: Changing paradigms and scaling up. AgREN Network Paper 59b* (London: Overseas Development Institute).

FAO. (1994). *Sustainable agriculture through integrated pest management*. Manila, Philippines: Twenty-Second Regional Conference for Asia and the Pacific.

Feder, G., Murgai, R., and Quizon, J. B. (2004). The acquisition and diffusion of knowledge: the case of pest management training in farmer field schools, Indonesia. *J. Agric. Econ.* 55, 221–243. doi: 10.1111/j.1477-9552.2004.tb00094.x

Hokkanen, H. M. T. (2015). Integrated pest management at the crossroads: science, politics, or business (as usual)? *Arthropod-Plant Interact.* 9, 543–545.

Matteson, P. C. (2000). Insect pest management in tropical Asian irrigated rice? *Annu. Rev. Entomol.*. 45, 549–74.

Muniappan, R., Heinrichs, E. A., and Fayad, A. (2016). "IPM packages for tropical crops," in *Integrated Pest Management of Tropical Crops*. Eds. R. Muniappan and E. A. Heinrichs (Dordrecht, Netherlands: Springer), 33–40.

Muniappan, R., Sharma, A., Hendery, S., Sidhu, J., Fayad, A., Ba, M., et al. (2021). *IPM Packages for Tropical Crops* (Virginia, USA: Center for International Research, Education, and Development, Virginia Tech), 72.

Myrick, S., Norton, G. W., Selvaraj, K. N., Natarajan, K., and Muniappan, R. (2014). Economic impact of classical biological control of papaya mealybug in India. *Crop Prot.* 56, 82–86. doi: 10.1016/j.cropro.2013.10.023

Neuenschwander, P. (2003). "Biological control of cassava and mango mealybugs in Africa," in *Biological Control in IPM Systems in Africa*. Eds. P. Neuenschwander, C. Borgemeister and J. Langewald (CABI, Oxon), 45–59.

Norton, G. W., Alwang, J., Kassie, M., and Muniappan, R. (2019). "Economic impacts of integrated pest management practices in developing countries," in *The Economics of Integrated Pest Management of Insects*. Eds. D. W. Onstad and P. R. Crain (Boston, MA, USA: CABI), 140–154.

Parsa, S., Morse, S., Bonifacio, A., Chancellor, T. C., Condori, B., Crespo-Perez, V., et al. (2014). Obstacles to integrated pest management adoption in developing countries. *Proc. Natl. Acad. Sci. U.S.A.* 111, 3889–3894. doi: 10.1073/pnas.1312693111

Pretty, J., Sutherland, W. J., Ashby, J., Auburn, J., Baulcombe, D., Bell, M., et al. (2010). The top 100 questions of importance to the future of global agriculture. *Int. J. Agric. Sustain.* 8, 219–236. doi: 10.3763/ijas.2010.0534

Ricker-Gilbert, J., Norton, G. W., Alwang, J., Miah, M., and Feder, G. (2008). Cost effectiveness of alternative IPM extension methods: and example from Bangladesh. *Rev. Agric. Economics* 30, 252–269. doi: 10.1111/j.1467-9353.2008.00403.x

Shepard, B. M., Hammig, M. D., Carner, G. R., Ooi, P. A. C., Smith, J. P., Dilts, R., et al. (2009). "Implementing integrated pest management in developing and developed countries," in *Integrated Pest Management: Dissemination and Impact*, vol. 2 . Eds. R. Peshin and A. K. Dhawan (Springer-Verlag, Berlin, Germany).

Stern, Y. M., Smith, R. F., van den Bosch, R., and Hagen, K. S. (1959). *The integrated control concept* Vol. 29 (Berkeley, California: Hilgardia), 81–101.

Yaninek, S., and Hanna, R. (2003). "Cassava green mite in Africa – a unique example of successful classical biological control of a mite pest on a continental scale," in *Biological Control in IPM Systems in Africa*. Eds. P. Neuenschwander, C. Borgemeister and J. Langewald (CABI, Oxon), 61–75.