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Molecular tools for sustainable management of invasive / indigenous pests for food and nutritional security in Africa

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Abstract

Integrated Pest Management (IPM) systems in Africa are increasingly leveraging cutting-edge molecular tools to enhance crop protection, promote sustainable agriculture and improve food and nutritional security. Advances in genomics, transcriptomics, and metabarcoding have enabled precise identification and monitoring of pest species and their natural enemies, including cryptic and invasive pests that traditional methods often overlooked. DNA barcoding and next-generation sequencing (NGS) facilitate rapid and accurate pest identification and early detection, enabling timely and targeted interventions. Molecular markers have been employed in elucidating invasion histories, genetic diversity, microbiome, population structures and distribution patterns of invasive pest species facilitating rapid deployment of management of these pests and diseases. Molecular tools such as DNA barcoding have also been used in the identification of microbial entomopathogens as components for incorporation into IPM systems. In addition, molecular surveillance tools have been employed to monitor pesticide resistance genes in pest populations, informing judicious use of chemical and IPM tools for crop protection. Furthermore, tools such as metabarcoding and transcriptomics have been used to evaluate the immunological effects of synthetic chemicals or entomopathogens on the target pests to ensure the sustainability of management strategies. The integration of these tools with ecological data enhances real-time decision-making and pest forecasting. However, challenges in comprehensive adoption of molecular biology tools still exists, including limited technical capacity, lack of equipment and infrastructure, and high costs and lack of access to high-throughput technologies across many African regions. Strengthening research networks and capacity-building initiatives are essential for mainstreaming molecular approaches to IPM strategies. By harnessing these innovations, Africa has the potential to transform pest management into a more precise, adaptive, and environmentally sound practice.

Keywords: Genomics, identification, invasive pests, IPM, metabarcoding, molecular tools, transcriptomics

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