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Sustainable Management of Date Palm Pests to Maintain Biodiversity and Wildlife in Saudi Arabia

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Abstract

The agriculture pest control programs were suffering from the extensive use of chemical synthetic pesticides and the lack of commitment to the environmental criteria. Negative impacts of the indiscriminate use of pesticides were drawn global attention to the adverse effects of that use on the biodiversity and wildlife. A holistic approach in sustainable pest management is imperative to maintain the biodiversity of fauna, flora, fungi and the whole biota in agriculture field especially in date palm orchards.

Keywords: Sustainable Pest Management; Date Palm Pests; Biopesticides; Bacillus thuringiensis; Beauveria bassiana and Metarhizium anisopliae; Red palm Weevil; Rhynchophorus ferrugineus; long horn date palm stem-borer beetle; Jebusaea hammerschmidtii; Entomopathogenic bacteria; Entomopathogenic fungi

Introduction

Date palm (*Phoenix dactylifera L.*) is the most cultivated plant in arid or semi-arid region, whereas considered a main source of food and the national income for some African and middle eastern countries. This perennial plant is widely cultivated in tropical and subtropical regions globally with an ancient evidence that it was originated to northern Africa and the Middle East from the 6th millennium BCE. Due to its capability to tolerate the hot weather, drought and levels of salinity, it is considered the most economically important cultivated crop in Saudi Arabia with over 31 million palm trees and production of 1541769 tonnes to occupy the 2nd global producer of dates after Egypt with 1690959 tonnes [1]. Furthermore, date fruits are distinguished by containing very important main nutrients such as proteins, Sugars, fatty acids along with some supplements such as, minerals, vitamins, polyphenols and antioxidants that may help for the treatment of anemia, nerve disorder, heart diseases, and immune activation to face various types of cancer as well [2]. Despite of the great efforts in terms of governmental support to develop the agriculture sector of date palm cultivation in Saudi Arabia, the yield of date fruits considered low in relation to the palm trees numbers compared with other date-producing and exporting countries [3].

The large numbers of plant diseases and insect or animal pests that attack palm trees, fresh and stored dates represent a huge challenge for date production especially as climate change is affecting the life cycle and behavior of some secondary pests switched to key pests [4]. Although, the Red Palm Weevil (RPW), Rhynchophorus ferrugineus have occupied the top sever cosmopolitan threat to palm trees, However, last five years, the long horn Date Palm stem-borer Beetle (DPB) Jebusaea hammerschmidtii, became a key pest of sustainable date palm production. To date, the chemical synthetic pesticides are the most adapted method to control date palm pests. In some cases, the farmers tended to saturate the palm trunk with systemic and contact insecticides to control RPW and DPB. Utilizing Aluminium phosphide as a fumigant has achieved efficacy in managing RPW. However, all other pests are likely to be the constraints in growing date palm.

The agriculture pest control have been developed from pre 1950 until now through four different stages as shown in (Figure 1). in the old era farmers were counted on the natural solar system in field sanitation long with agriculture practices as plowing, hoeing, insolation and mechanical control as well to eliminate egg masses, pupa, and living instar of insect pests as possible. The next stage from 1950 to 1970 witnessed the industrial revolution of organic synthetic pesticides which started with organochlorinated pesticides such as DDT. Farmers tended in that period to extensive

use of agrochemicals especially pesticides using the concept of pest eradication regardless any environmental consequences or adverse effects on the human or living beings and the whole biota.

Silent spring was the first environmental alarm to whom it may concern at all levels of responsibility from the international organizations, manufacturer of agrochemicals down to the end users as farmers. Beneficial animals and birds in the field, which were well known as farmer friends in maintaining the population of insects under the critical threshold, were in extinction [5]. Concerted efforts of the international organizations represented in Food and Agriculture Organization of united nations (FAO) and The US- Environmental Protection Agency (EPA) and the scientists, pesticide manufacturers and farmers were conducted to adopts the idea of coexistence with the pest as novel concept at that time about Integrated pest management (The third stages- Figure 1). In 2012 the concept of sustainable food production and sustainable food security have been showed up and spread worldwide as a global demand for all countries as an attempt to maintain the environment in terms of water, soil, air, wildlife, biodiversity in the agriculture fields, non-target organisms, natural enemies, humans. The good agricultural practices paved the way forward towards sustainability which is considered as an rescue approach from the repercussions of climate change resulting from the intensive indiscriminate use of agrochemicals.

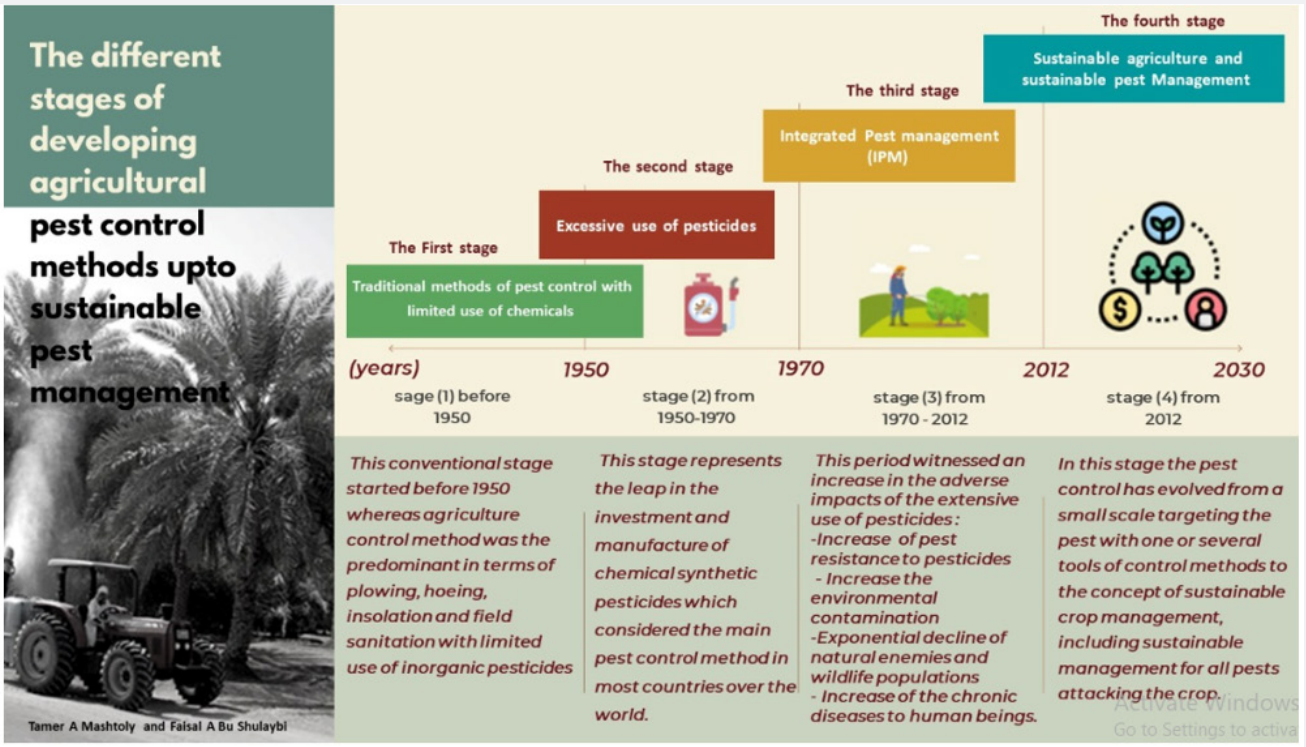

Figure 1: The different stages of developing agriculture pest control methods up to sustainable pest management approach.

The irrational use of pesticides resulted in adverse environmental impacts such as insecticide resistance, economic loss of yield, negative effects on non-target organisms, killing the natural enemies, imbalance of biodiversity in the agro-ecosystem, environmental contamination, and increasing of pesticide residues levels in the produced dates. Hence, adverse effects in human health. Therefore, A holistic approach in sustainable pest management is imperative to maintain the biodiversity of fauna, flora, funga and biota.

The biopesticides based on bacteria such as Bacillus thuringiensis subsp kurstaki (Btk), aizawai (Bta), and serovar japonensis (Btj), Bacillus cereus, Bacillus weihenstephanensis, and Pseudomonas spp proved the potential as an eco-friendly insecticides on insect pests belong to orders of Lepidoptera, Diptera, Coleoptera, and Orthoptera [6-9]. The entomopathogenic bacteria are safe for humans, biotic factors of the environment such as beneficial vertebrates, and arthropods in addition to having no pre-harvest intervals on agricultural products [10]. Meanwhile, B. thuringiensis produce 3 domain of Cry protein toxins that bind into specific receptors in the midgut apical microvilli membrane, after they were cleaved and oligomerized, causing pore formation that leads to epithelial disruption in terms of ion leakage, cell lysis, septicemia and then death [11-12].

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The entomopathogenic fungi such as Beauveria bassiana and Metarhizium anisopliae (Green muscardine) have been widely used with restrictions related to the weather humidity to control beetles and weevils in the palm date fields. The entomopathogenic fungi have proved effective due to their potential infectious to insects [13-14]. Beauveria bassiana Balsamo, Beauveria brongniartii Petch, Metarhizium anisopliae Sorokin, and Isaria fumosorosea Wize and its metabolites, are considered most commonly used fungi in biocontrol of coleopteran pests [15-17]. Fungi well known as eco-friendly environmental safe in use and efficient biological control agent to wide spectrum of insect among them the red palm weevil, R. ferrugineus [18]. Thereby, the maximization of utilizing biopesticides based Entomo-Pathogenic Fungi (EPF) or ready to use mycoinsecticides in controlling palm pests is a good alternative to chemical synthetic pesticides.

The concept of sustainable management of palm pests

It is a sustainable approach to pest management using the available environmental and agricultural methods, which aims to provide an appropriate and safe environment for the growth of the crop while maintaining the pest population below the critical limit of infection in a sustainable manner yearly without the need to re-settle the control elements annually, but only we target increasing, propagation and preservation of them, thus achieving profit at the lowest costs in the long run while preserving natural environmental resources such as irrigation water, agricultural soil, groundwater and the produced date fruits without contamination.

Factors affecting the Sustainability

There are two types of factors affecting the sustainability in date palm fields

Pest-specific factors: To sustain a pest management strategy, it is necessary to use ecological prediction of pest population, the behavioral changes that may occured , the levels of tolerance or resistance to chemical and biological pesticides, and the availability of natural enemies in the palm fields.

Date palm specific factors: The Integrated horticultural management of palm orchards, starts from taking care of the soil and its fertility, irrigation water characteristics ensuring that the percentage of its salinity matches the capabilities of the cultivated date palm variety. Bio-fertilization to meet the needs of the palm in each stage of production throughout the year. Routinely field sanitation of the previous palm wastes or the wastes resulting in palm care service to make the palm trunk and palm head to be improper environment for the growth and reproduction of insect , animal pests, fungal and bacterial plant diseases as well.

Conclusion

The sustainable agriculture is wide spectrum approach to preserve the biotic and a biotic environmental factors over the globe. Although, this approach is not individual responsibility , however, each of us should contribute to success the governmental efforts by reducing the use of chemical in agricultures especially in cultivated products that may eaten directly without processing to be safety food. A holistic approach in sustainable pest management is imperative to maintain the biodiversity of fauna, flora, funga and biota. Field schools may be effective to spread the awareness about the importance of establishing an sustainable strategy in date palm fields. Biopesticides based on bacteria and fungi are eco-friendly environmentally safe for human and living beings. In addition to having no pre-harvest intervals on agricultural products. Meanwhile, they have the potential to be complementary or alternative tools in managing date palm pests.

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