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Review Article

Global Warming and Tropospheric O_3 Regimes: Precursor Responses on Pest Dynamics

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Abstract

Our societies must consider, manage, and address significant environmental changes. Some of these changes are related to how we produce and consume, while others are related more generally to climate changes, particularly global warming and elevated tropospheric ozone levels and their possible future impacts on ecosystems and biodiversity. However, information concerning predicting these impacts of tropospheric ozone (O_3) regimes on the number of generations of pests and the consequences of O_3 regimes on pest dynamics and outbreaks in the agro-ecosystem and reclaimed lands are fragmentary and no detailed information are available.

Keywords: Global warming; Tropospheric ozone; Pest dynamic; Bioindicators

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Introduction

There is no doubt that lots of problems in pest control are facing farmers due to different reasons including inefficacy or pesticides misuse, resistance, pest outbreaks and climate changes. Every year; deleterious insect pests are attaching economic crops (cotton), cereal crops (wheat, barley and rice), and vegetable and fruit crops causing great economic loss which threaten our self-sufficiency of food and national security. Such losses, if it is not planed, will increase the risk of malnutrition and hunger among population as reported by UNEP [1], especially with the low level of Gross Domestic Production (GDP) and per capita income. Since early 90s, the Ministry of Agriculture and Land Reclamation emphasizes to spread the philosophy of Integrated Pest Management (IPM) to meet the needs of the growing human population to utilize all suitable techniques and approaches for maintaining pest population levels below those causing economic losses. From this aspect, insects could be considered as a good indicators of threatened nature [2]. Drastic environmental alterations must be viewed, controlled and resolved by our societies, some of these alterations are directly related to how we create and consume, while others are indirectly related to climate changes, in particular global warming and increased tropospheric ozone level, and their effects on ecosystems and biodiversity [3,4]. These effects were noticeable over the last decades [5-11]. However, the knowledge concerning the possible effects of O_3 on trophic interactions remains insubstantial. It was notable that ozone (O_3) level in the lower tropospheric layer has increased since the preindustrial age [11,12]. This level is considered to remain at potentially phytotoxic levels to the ecosystem with further implications to ecological processes and trophic cascades [12]. It is recommended to do additional studies on the dynamics and outbreaks of pests under predictions of future environmental changes for avoiding further chemical regulations since we should orient to more the Integrated Biodiversity Management (IBM) and this trend is currently carried out worldwide. This review is willing to shed light and provide a future solid ground for augmentation of the goals of IPM for the welfare of our society which is based on two perspectives (I & II).

Perspective I. Pest Generations and Global Warming

Temperature is the most important factor regulating life and the rise of temperature, Global warming, is a worldwide challenging stress and Egypt is potentially vulnerable to the effect of global warming as reported by World Bank [13]. The decline in agriculture activities and self-sufficiency of strategic crops due to global warming is expected to range from 10 to 60% [13]. Indeed, global warming is a problem forcing insects pests to produce more or less generations [14] or invading new places [15]. Thus, the decline in crop productivities together with pest invasion will be a great threat to our national security. Hence, it is important to study in details the response of pest dynamics towards global warming.

Perspective II. Tropospheric Ozone

Tropospheric ozone (O_3) is recognized as a significant phytotoxic air pollutant and greenhouse gas. O_3 levels have increased by approximately 60–100% since pre-industrial times in East Asia and North Africa and remain elevated [16-18]. The effects of elevated tropospheric O_3 levels have been widely studied in plants [19-21]. However, limited data exist for insects [22] and particularly pests [6]. O_3 levels will expose to an additional effect as a result of global warming. Global change and O_3-induced alterations in plants may alter the suitability of plants to insects, thus affecting plant-insect interactions in a complex manner [6,22,23]. Obviously, global warming and changes in ozone regimes will exert an additional effect on pest dynamics and self-sufficiency of food [24]. However, it is still unclear how these two factors would act (positively or negatively) on the pest dynamics and host-plant preference. A series of field and laboratory no-choice assays should be conducted. Analysis of nutritional indices on ozonated and control tissues are recommended to provide a clear views on pest consumption and insect-plant interactions [12]. These indices include: Consumption Index (CI), mass Growth Rate (GR), Efficiency of conversion of both ingested and digested food (ECI, ECD) and Approximate Digestibility (AD), together with enzymatic bioassays which recommended to be conducted simultaneously to assess the possible effects of O_3 on physiological performance [12]. These bioassays could include the following:

a) Detoxifying enzymes i.e., α and (β) esterases for measuring resistance and response to environmental stimuli and metabolism of endo- and exogenous compounds.

b) Transaminase enzymes [Glutamic-Oxaloacetic Transaminase (GOT) and Glutamic–Pyruvic Transaminase (GPT)] and carbohydrate hydrolyzing enzymes.

Conclusion

Experimentations on global warming and ozone regimes could reveal potential consequences over insect generations. These consequences act directly and indirectly by changing the growth and nutrition of the pest as gathered from results from the available literatures. However, the mechanism of how O_3 regimes on host plants may enhance or suppress the insect performance is not yet clarified and should be deeply examinations. Moreover, which stage (instars) that could serve as the most effective O_3 bioindicator among other instars and the proper timing of pest control require further investigations.

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Author Contribution

ElSayed Wael: Conceptualization, Writing; Abu ElEla Shahenda and Koike Takayoushi: Reviewing and editing.

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