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Climate change and pesticide resistance

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DESCRIPTION

Climate change has the potential to alter the global distribution of pests and their resistance to pesticides, threatening global food security in the twenty-first century. However, forecasting where these changes will occur and how they will impact current pest control efforts is difficult. Using experimentally parameterized and field-tested models, we show that climate change has increased the overwintering range of a global agricultural insect pest, the diamondback moth, by 2.4 million km2 globally over the last 50 years. Pesticide resistance levels are linked to the species' overwintering range, according to our analysis of global data sets: mean pesticide resistance was 158 times higher in overwintering sites compared to seasonal occurrence sites. Climate change, by facilitating local persistence all year, has the potential to promote and expand pesticide resistance in this destructive species globally. These ecological and evolutionary changes would significantly reduce the effectiveness of current pest control efforts and could result in significant economic losses. Anthropogenic climate change increases pest crop losses, and widespread pesticide use promotes pesticide resistance, threatening global food security and food safety in the twenty-first century. Climate change, in particular, has expanded the geographic range of many pests in previously low-pest-risk areas. Simultaneously, pesticide use and resistance have increased in these areas. Climate change, by facilitating local persistence all year, has the potential to promote and expand pesticide resistance in this destructive species globally.

These ecological and evolutionary changes would significantly reduce the effectiveness of current pest control efforts and could result in significant economic losses. While these patterns appear to be linked, climate-mediated range shift and pesticide resistance have traditionally been studied separately. As a result, it is still unknown how changes in pest distribution will affect pesticide resistance development and distribution under future climate change scenarios. To comprehend the relationship between range shifts and pesticide resistance, it is necessary to first comprehend how climate change will alter the geographic range of pest species. While much progress has been made in documenting changes in pest distributions as a result of climate change, predicting how distributions will change in the future is difficult. Such forecasts necessitate the use of mechanistic models to determine which aspects of climate change are influencing pest species distribution. In the search for mechanisms, cold temperatures have emerged as a key factor limiting the spread and range of insect species; species must survive cold stress in order to resume growth, development, and reproduction when conditions improve. As a result, many pest species migrate in annual cycles from warm overwintering regions to colder regions in late spring and early summer, only to disappear in the colder regions in fall and winter. Pest species may thus be present locally all year or only as seasonal visitors, depending on the local conditions. The distinction between permanent and transient occurrences is critical because it determines pest population growth rates and damage periods at a given site. Importantly, the same factor may influence the likelihood of pesticide resistance in pests.

CONCLUSION

Pests in permanent populations are frequently exposed to the same pesticide, allowing resistant individuals to proliferate year after year. This may eventually result in local adaptation and pesticide resistance accumulation. Pests with seasonal occupancy, on the other hand, are only exposed to local conditions, including pesticides, for a portion of the year. If pests have multiple generations within a given season, this seasonal exposure may result in a short-term increase in resistance over time.

On the other hand, long-term local adaptation to a unique condition in a given location is severely limited in transient populations because locally adapted resistant phenotypes die in cold winter temperatures or emigrate at the end of the season, while colonisers in the following seasons come from different locations. If climate change expands the conditions that allow a pest to persist locally, it may alter a pest's ability to develop resistance to locally used pesticides. However, predicting where such a climate-mediated increase in resistance occurs should confirm the link between pest overwintering range and pesticide resistance.