Bacillus thuringiensis*, subspecies *kurstaki

There are several pesticides that contain the active ingredient Bt_k, which are the spores of the naturally occurring bacterium *Bacillus thuringiensis*, subspecies *kurstaki*. These spores produce an endotoxin that is specific to the caterpillar stage of moths and butterflies in the *Lepidoptera* family. Even though Bt_k is not considered a chemical, it still retains potent insecticidal properties. Bt_k is dormant as a spore, and only becomes toxic once it is consumed and activated by the alkaline environment (pH >9) of the caterpillar's gut. In contrast, mammals have an acidic stomach (pH <2). Therefore, this pesticide leverages the unique physiology of *Lepidoptera* caterpillars to prevent non-target toxicity in nearly all organisms tested: mammals, birds, fish, plants, aquatic organisms, and insects- including bees and earthworms- outside the *Lepidoptera* family. Notably, Bt_k application has been used for more than 50 years, and many formulations are approved for organic crop production, further evincing the pesticide's low risk when used appropriately.

The most likely routes of human exposure to Bt_k occur *via* food or inhalation stemming from accidental drift; at expected environmental concentrations (EEC), neither exposure represents a major health risk. Crops can be exposed to Bt_k either through direct application or drift, resulting in residue on food. In contrast to nearly all other pesticides, the EPA has waived the maximum residue limit of Bt_k on foods due to its extremely low risk to human health. Inhalation of Bt_k is also deemed practically non-toxic. Although inhalation does not cause allergies or asthma in adults and children, some studies indicate that individuals with these pre-existing conditions might be more sensitive to Bt_k. Lastly, Bt_k poses low- yet reversible- toxicity as a skin and eye irritant at doses that far exceed EEC; thus, this health risk is considered low.

Bt_k rapidly degrades on leaves, with an estimated half-life of 2-4 days. Additionally, spore viability in soil is reduced 10-fold after two weeks. Its low soil permeability ensures that spores are retained in the top three inches of the soil, thereby inhibiting its ability to leach into aquifers. Although spore propagation is possible, acidic soils- which dominate the spruce-fir forests in northern Maine- decrease this chance and minimize the risk of off-target deposition.

The environmental risks of Bt_k are minimal, but are still present. This is particularly salient if the pesticide is applied before a rainstorm, which could carry the spores to a waterway *via* runoff. Additionally, runoff can also occur if the pesticide is applied to soils with a high-

water table, such as forested wetlands. In northern Maine, this risk is reduced when the seasonal high-water table begins to recede by late May.

In summary, the EPA classifies Bt_k as non-carcinogenic, and its ingestion or inhalation is deemed practically non-toxic to mammals, birds, fish, invertebrates, and non-target insects at EEC. The minimal risk posed by Bt_k generally aligns with the assessment made in Europe.

References

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