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Agrochemicals interact synergistically to increase bee mortality

[Harry Siviter](#) , [Emily J. Bailes](#), [Callum D. Martin](#), [Thomas R. Oliver](#), [Julia Koricheva](#), [Elouise Leadbeater](#) & [Mark J. F. Brown](#)

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Abstract

Global concern over widely documented declines in pollinators^{1,2,3} has led to the identification of anthropogenic stressors that, individually, are detrimental to bee populations^{4,5,6,7}. Synergistic interactions between these stressors could substantially amplify the environmental effect of these stressors and could therefore have important implications for policy decisions that aim to improve the health of pollinators^{3,8,9}. Here, to quantitatively assess the scale of this threat, we conducted a meta-analysis of 356 interaction effect sizes from 90 studies in which bees were exposed to combinations of agrochemicals, nutritional stressors and/or parasites. We found an overall synergistic effect between multiple stressors on bee mortality. Subgroup analysis of bee mortality revealed strong evidence for synergy when bees were exposed to multiple agrochemicals at field-realistic levels, but interactions were not greater than additive expectations when bees were exposed to parasites and/or nutritional stressors. All interactive effects on proxies of fitness, behaviour, parasite load and immune responses were either additive or antagonistic; therefore, the potential mechanisms that drive the observed synergistic interactions for bee mortality remain unclear. Environmental risk assessment schemes that assume additive effects of the risk of agrochemical exposure may underestimate the interactive effect of anthropogenic stressors on bee mortality and will fail to protect the pollinators that provide a key ecosystem service that underpins sustainable agriculture.