Apis mellifera, commonly known as the honey bee, is one of the quintessential pollinators throughout most of the world (Fikadu, 2020). Bees survive in the wild using hives that act as reproductive sanctuaries, and storage facilities for nutrients, allowing them to live through winter months (Decourty et al., 2003). Bees also use a hierarchical system that divides members of the hive into different roles, each fulfilling an important function (Fikadu, 2020). Honey bee behaviour can be a clear indicator of the organism's health, as well as beehive health in general. Foragers, for example, use olfactory learning and sucrose detection behaviours to identify food sources such as flowers, and further information on how pesticides affect important behaviours like these is necessary given that these chemicals are becoming increasingly common as a result of the globally expanding agricultural industry (Poquet et al., 2016). Through the examination of multiple studies, it has been established that one of the most significant impacts on a multitude of honey bee behaviours is exposure to insecticides (Fikadu, 2020). This review describes the effects of the most impactful varieties of three different classes of insecticides; phenylpyrazoles, neonicotinoids, and organophosphoruses.

Pre-existing research has focused on the direct impact that insecticides have on honey bee olfactory learning and memory, sensitivity to sucrose and water, and mobility, by affecting structures such as bee antennae or the brain (Decourtye et al., 2004). This review summarizes that the effects of these chemicals have been elucidated using laboratory techniques and controlled setups tailored to examine a specific behaviour, such as olfactory memory. Furthermore, this review noted that when testing any behaviour, honey bees were typically exposed to pesticides by both oral and topical application on the thorax. Impairments to olfactory learning and memory were tested using Pavlovian conditioning with a drop of sucrose acting as an unconditioned stimulus, and another odour such as coffee beans acting as a conditioned stimulus (El Hassani et al., 2005). The phenylpyrazole insecticide fipronil, as well as the neonicotinoids acetamiprid, thiamethoxam, clothianidin, and imidacloprid, were all found to contribute to reduced olfactory learning and memory (Aliouane et al., 2009; Decourtye et al., 2004; El Hassani et. al., 2005; El Hassani et al., 2008; Lambin et al., 2001; Schneider et al., 2012). Effects on sucrose and water sensitivity were evaluated based on the propensity for bees to display their proboscis extension reflex upon exposure to either sucrose or water (El Hassani et al., 2008). Fipronil, along with acetamiprid and thiamethoxam resulted in a decrease in sucrose responsiveness (Aliouane et al., 2009; El Hassani et. al., 2005; El Hassani et al., 2008). Acetamiprid and thiamethoxam were also found to induce an increase in water consumption (Aliouane et al., 2009; El Hassani et al., 2008). Pesticide effects on mobility were generally determined using open-field-like apparatuses which allowed for observation of the bees' vertical displacement (El Hassani et al., 2005). Fipronil, imidacloprid, clothianidin, and organophosphorus methyl parathion was observed to contribute to a reduction in mobility overall (Aliouane et al., 2009; Decourtye et al., 2004; Lambin et al., 2001; Schneider et al., 2012). Notably, methyl parathion reduced bee mobility by way of a reduced tendency to perform communicative dances (Guez et al., 2005).

Many of these honey bee behaviours which are negatively affected by pesticide exposure are critical to foraging efforts that allow entire hives to survive. Olfactory learning and memory are vital to foraging, as bees need to recall the location of food sources for communication to other foragers (Decourtye et al. 2004). Communication amongst foragers in the form of dances is equally as important, and a reduction in the tendency of foragers to communicate can markedly affect a hive’s success (Guez et al., 2005). Sucrose sensitivity is also vital to ensuring proper foraging and is involved in the role allocation of hive members (El Hassani et al., 2005). Mobility and activity is the foundation of foraging, and thus, reduced foraging as a result of insecticide exposure can endanger hives (Schneider et al., 2012). Further study is recommended in establishing whether or not lab results are consistent with real-world effects at the hive in the wild (Guez et al., 2005).

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