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# Effect of powdered sugar spreading on the mite (*Varroa jacobsoni* Oudemans) management and brood development of the Indian honey bee, *Apis Cerana indica* F. (Hymenoptera: Apidae)

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**Abstract**
Studies were carried out at the Bee garden, Department of Plant Protection, Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli to investigate the effect of powdered sugar spreading on the mite (*Varroa jacobsoni* Oudemans) management and brood development of the Indian honey bee (*Apis cerana indica* F.). Use of acaricides and other chemicals for management of *Varroa* mite has numerous side effects on the honey bees, bee products and consumers. Dusting of honey bees with powdered sugar is considered as safer mechanical method but intensive use of dusting or spraying over bees is not recommended. Hence, in this investigation was made to test the effect of powdered sugar spreading over the screened bottom board against powdered sugar dusting. However, the number of *Varroa* mite found on the adult worker bees had no significant difference between the treated (0.35 ± 0.10/ 50 workers) and untreated colonies (0.61 ± 0.08/ 50 workers).

**Keywords:** *Varroa* mite, safer management, powdered sugar dusting, powdered sugar spreading

## Introduction
Honey bees are required for the effective pollination of crops and are therefore critical to world agriculture for human food production (Chantawannakul, 2018) [8]. Worldwide, bees pollinate more than 400 crop species (James and Singer, 2008) [14]. These honey bees are affected by various pathogens such as viruses, bacteria, fungi, protozoan and parasitic mites (Bailey, 1968) [4]. The ectoparasitic mites, *Varroa destructor* Anderson & Trueman (Acari: Varroidae) and *Varroa jacobsoni* Oudemans (Acari: Varroidae) that parasitise pupae and adult bees of *Apis mellifera* L. and *Apis cerana* F. are considered to be the major threat to apiculture. They feed on the haemolymph of honey bees which causes wound sites and often harbour pathogenic infections (Probasco, 2009) [17]. *Varroa* mites act as vectors for a number of honey bee pathogens and may weaken the immune systems of their hosts, leaving them vulnerable to infections. Varroosis (varroatosis) of the honey bee, *A. mellifera* is an epizootic disease caused by an ectoparasitic mite *V. jacobsoni*, which was first described on the Asian honey bee, *A. cerana* (Colin, 1990) [9].

A wide array of chemical compounds, including a range of synthetic acaricides and insecticides, are widely applied on beehives to manage these parasites (Bajuk *et al.*, 2017) [5]. Acaricides like fluvalinate, coumafos, amitraz, cymiazol, flumethrin, thymol, oxalic acid and formic acid are used for the management of *Varroa* mites (Bogdanov, 2006; Johnson *et al.*, 2010) [6, 15]. Use of drugs and other chemicals have numerous side effects on the honey bee (Gregorc and Ellis, 2011) [13], bee products (Bogdanov, 2006) [6] and consumers (Stanimirovic *et al.*, 2005, 2007) [18, 19] hence, safer management methods are needed.

Hygienic behaviour in honey bees is the dominant defense mechanism against brood diseases and also against *Varroa* mites infesting brood cells (Evans and Spivak, 2010) [11]. Grooming is regarded as an important defence mechanism of Asian honey bees, *A. cerana* against the ectoparasitic *Varroa* mite. Auto-grooming when the activity is limited to the infested bee. Allo-grooming when group of nest-mates joined the grooming effort of the parasitized bee. Allo-grooming is an important mechanism of defense against phoretic *Varroa* mites by the original host, *A. cerana* F. (Peng *et al.*, 1987; Büchler *et al.*, 1992) [16, 7].

One of the safest methods to reduce *Varroa* infestation in honey bee colonies is the use of mechanical methods. Dusting or spraying honey bees with materials like powdered sugar or oxalic acid solution is considered as safe mechanical methods (Abou-Shaara, 2014) [1]. The intensive use of dusting or spraying over bees is not recommended because these may cause

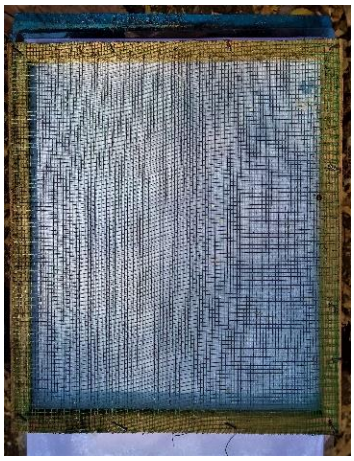
respiratory blockage in honey bees. The intensive use of dusting or spraying over honey bees can reduce their survival ability and is not preferable. During dusting or spraying applications are strictly recommended to avoid exposure of small group of bees to high amounts of treatment materials like powdered sugar (Abou-Shaara *et al.*, 2016) [2]. Hence, in this investigation was made to test the effect of powdered sugar spreading on the screened bottom board against powdered sugar dusting over honey bees.

**Materials and Methods**

The honey bee, *A. cerana* colonies available in the Bee garden at the Department of Plant Protection, Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli were collectively utilized to conduct this experiment over a period of four weeks. For one treatment five colonies were maintained. All the colonies had equal frames frame strength (four frames) and the queens were of uniform age. The number of *Varroa* mites that had fallen on the bottom board were assessed every week in a 1250 $cm^2$ area using the same transparent grid in the control bee hives while in the treatment bee hives the powdered sugar spread were collected and dissolving the powdered sugar in a wide mouthed whitish container containing water.

a) Sugar spreading on the screened bottom board for mite assessment in treatment bee hives.

b) Sugar spread dissolved in water contained in the whitish container for mite assessment in treatment bee hives.



c) Bottom board set up for mite assessment in control bee hives.

d) Worker honey bees collected for *Varroa* mite assessment.

Mite assessment in adult honey bees were also made by collecting 50 workers inside a 400 ml PET jar and by shaking them vigorously after adding a heaped table spoon of powdered sugar. The dislodged mites were counted after dissolving the powdered sugar in a wide mouthed whitish container containing water and the dust-laden bees in jars were released back into the bee hives. The powdered sugar was dusted on the honey bee adults for control colonies and spreading of powdered sugar on the bottom board for treated colonies were done every week after all the above observations were recorded (Dietemann *et al.*, 2015) [10].

**Results and Discussion**

The experimental results showed that there was no significant difference between the number of cells in the powdered sugar spreading (156.91 ± 1.45/100$cm^2$) and powdered sugar dusting (154.70 ± 0.89/100$cm^2$). On brood development, the results indicated that there was no significant difference in egg laying by the queen following powdered sugar spreading (22.34 ± 2.31/100$cm^2$) and powdered sugar dusting (18.08 ± 1.19/100$cm^2$). There was no significant difference in the number of larvae and pupae in brood cells between powdered sugar dusting (31.33 ± 5.40/100$cm^2$ and 49.59 ± 11.06/ 100 $cm^2$) and powdered sugar spreading (31.45 ± 2.20/100$cm^2$ and 60.04 ± 10.40/ 100 $cm^2$). The number of pollen / bee bread filled cells on *A. cerana* combs did not differed significantly due to powdered sugar spreading to the colonies (9.65 ± 1.11/100$cm^2$). The number of honey filled cells was not

significantly different in colonies between the treated (20.01 ± 1.50 /100cm$^2$) and untreated colonies (17.15 ± 0.92 /100cm$^2$). The results suggest that powdered sugar treatment as described does not have any effect on the capped brood or the brood development in the colonies (Fakhimzadeh, 2001) [12]. The number of *Varroa* mites found on the floor board of the experimental colonies did not show any significant difference among the treated (1.10 ± 0.31/ 1250 cm$^2$) and untreated colonies (2.16 ± 0.46/ 1250 cm$^2$). However the number of *Varroa* mite found on the adult worker bees had no significant difference between the treated (0.35 ± 0.10/ 50 workers) and untreated colonies (0.61 ± 0.08/ 50 workers) (Table 1). Since there was no significant difference it is concluded that the powdered sugar spreading is not effective over powdered sugar dusting. But according to Fakhimzadeh (2001) [12] and Aliano and Ellis (2005) [3] there was no side effect on the optimum usage of powdered sugar for dusting over the honey bees and egg removal resulting from using large amount of powdered sugar to remove mites may be negligible. Therefore there is a need for further investigation on powdered sugar spreading and powdered sugar dusting for honey bees on *Varroa* mite management.

**Table 1:** Effect of powdered sugar spreading (treated) and powdered sugar dusting (untreated) on the brood development and mite population in *A. cerana*

| Categories | | Dusting of powdered sugar + screened bottom board | Spreading of powdered sugar on the screened bottom board | *t* - value |
|---|---|---|---|---|
| Brood examination/ 100cm$^2$ (no.) | Cells | 154.70 ± 0.89 (12.46) | 155.30 ± 0.59 (12.48) | NS |
| | Eggs | 18.08 ± 1.19 (4.30) | 22.34 ± 2.31 (4.76) | NS |
| | Larval cells | 31.33 ± 5.40 (5.58) | 31.45 ± 2.20 (5.64) | NS |
| | Capped cells | 49.59 ± 11.06 (6.93) | 60.04 ± 10.40 (7.68) | NS |
| | Pollen cells | 6.34 ± 0.70 (2.23) | 8.18 ± 0.83 (2.93) | NS |
| | Honey cells | 17.15 ± 0.92 (4.20) | 20.01 ± 1.50 (4.52) | NS |
| Debris examination (no.) | Fallen mites/1250 cm$^2$ | 2.16 ± 0.46 (1.61) | 1.10 ± 0.31 (1.24) | NS |
| Mite population (no.) | Phoretic mites/50 workers | 0.61 ± 0.08 (1.05) | 0.58 ± 0.06 (1.04) | NS |

Figures in parentheses are $\sqrt{x+0.5}$ transformed values
Mean ± SE of four observations
**significant 0.05% level

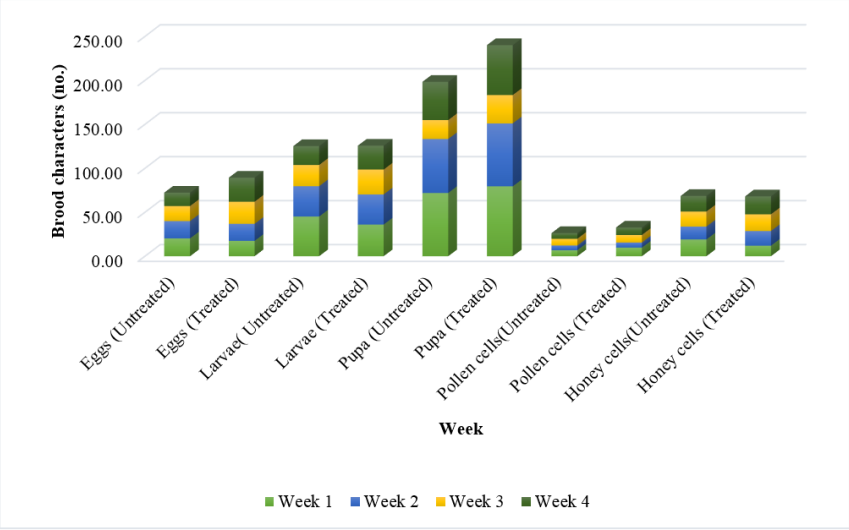



**Fig 1:** Effect of powdered sugar spreading and powdered sugar dusting on brood development of *A. cerana*

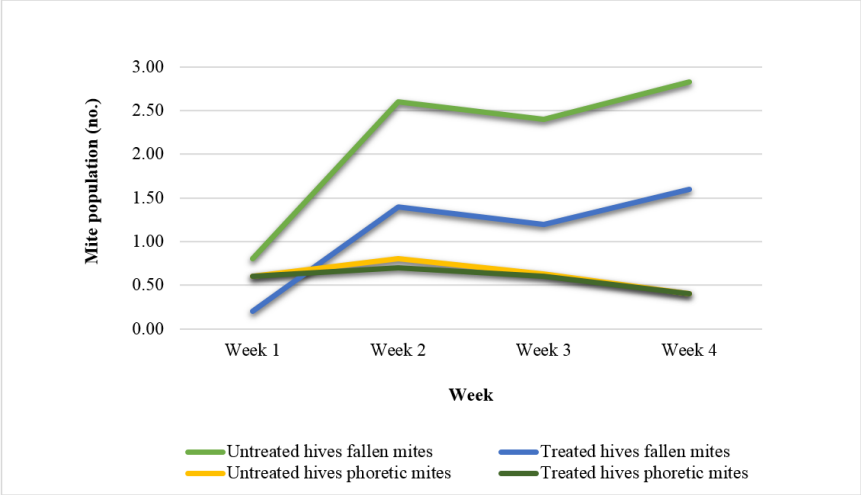



**Fig 2:** Effect of powdered sugar spreading and powdered sugar dusting on *Varroa* mite population of *A. cerana*

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