World Academy of Science, Engineering and Technology
International Journal of Agricultural and Biosystems Engineering
Vol:8, No:1, 2014

Effects of Modified Bottom Boards on the Performance of Honeybee Colonies

M. Keshlaf, R. Spooner-Hart

Open Science Index, Agricultural and Biosystems Engineering Vol:8, No:1, 2014 publications.waset.org/9997263.pdf

Abstract**—**Australia does not have varroa mite. However, we investigated whether modified hive bottom boards used for varroa mite management in honey bee colonies had other benefits, for honey production. We compared a number of colony parameters between hives fitted with tube, mesh and conventional (solid) bottom boards in two locations in eastern Australian, Richmond NSW and Castlemaine Victoria. Colonies housed in hives with mesh and tube bottom boards were not significantly superior to those in hives with conventional bottom boards with regard to bee flight activity, nor did they produce more honey, brood or stored pollen, in either experimental site. Although the trial was conducted over only one season, it is suggested that there may be no benefit in Australian bee keepers changing from using conventional bottom boards in the absence of varroamite.

Keywords**—***Apis mellifera*, honey production, mesh bottom boards, tube bottom boards.

I. Introduction

THE parasitic mite *Varroa destructor* Anderson &Trueman is a major pest of honeybees, *Apis mellifera* L., around the world [1], including New Zealand [2]. The only major country where it does not currently exist is Australia [3], and Oasis in Libya [4]. One strategy in varroa mite management has been the use of modified hive bottom boards [5], [6]. Most of these modified bottom boards utilize metal mesh which aims to cause the varroa mites to fall out of the hive structure, either for monitoring [6] to optimize timing of control strategies, or to directly reduce in-hive mite populations [7]-[10]. However, Pettis and Shimanuki [7] concluded that while the growth rate of varroa mite populations was reduced in fitted hives, they were not sufficient to prevent mites building up to damaging levels.

Mesh bottom boards have also been evaluated for their ability to reduce small hive beetle, *Aethina tumida* Murray, entry into hives. It was thought that the use of mesh bottom boards would also increase in-hive ventilation, particularly when used in conjunction with reduced hive entrances to restrict *A. tumida* entry [11].

While increased hive ventilation associated with mesh bottom boards has been suggested to positively contribute to other in-hive characteristics, the results are somewhat inconclusive. Ellis and Delaplane [12], for example, concluded that bottom board type did not affect any of the colony strength parameters except honey production (where there was more honey in colonies with conventional wooden bottom boards than screened ones). However, Ellis et al. [11] reported that in hives with restricted entrances, there were significantly fewer frames of adult bees than those with open entrances, although there were more in such colonies with mesh floors. Pettis and Shimanuki [7] reported that in their study, colonies with mesh bottom boards had significantly more sealed brood than colonies on normal bottom boards. Similar results were reported by Coffey [13].

Tubed bottom board,an alternative to mesh for bottom boards, was invented in 1993 by a French beekeeper. This board has been evaluated in two recent, unpublished, trials in France [14], [15]. Both compared the tube board with mesh boards for their effects on the number of mites falling from hives via bottom boards. Also, they found that mean brood areas were slightly higher in the tube board hives in early season, but subsequently there was no difference. Both sets of hives produced similar levels of honey. Results for the second investigation showed higher level of stored honey early in the season in hives with tube bottoms.

Our objectives of the study were to assess whether bottom boards primarily designed to control varroa mite could lead to increase in honey production and facilitate the in-hive storage of pollen. Also comparing mesh and tube bottom boards against conventional wooden boards for their ability to achieve the above desired outcomes.

II. Methodology

The studies were conducted in two locations, University of Western Sydney (UWS) NSW [33°35'S, 151°10'E], and Castlemaine, Victoria [37°02'S, 144°12'E]. Hives were headed by mated sister queens of *Apis mellifera ligustica* L., and equalized for sealed brood, stored pollen and honey prior the commencement of the investigation. Ten and eight frame Langstroth hives were used at UWS and Castlemaine respectively. Colonies were arranged in a randomized complete block design, and hives were equally assigned to one of three treatments, namely: Conventional solid bottom board (control), Mesh-screened bottom board, or Tube bottom board.

The tube bottom boards were supplied by Australia-World Enterprises Pty Ltd (Sutton Grange, Vic). They comprised a wooden frame with similar dimensions to the inner surface of the hive body. Plastic tubes of 34mm diameter and 450mm length were set 3.5mm apart by three plastic spacer struts, and with an open space between the tubes. The mesh-screened bottom board was composed of stainless steel mesh (3mm), and was modified from conventional bottom boards. Thus,

Dr. Marwan Keshlaf is with the University of Tripoli, Tripoli, Libya (phone: 218-91497-4142; fax: 218-214627915; e-mail: Marwan_keshlaf@ yahoo.com.)

Pro. Robert Spooner-Hart is with the University of Western Sydney, Locked Bag 1797 Penrith South DC, Australia. (phone: 61-245701429; fax: 61-245701314; e-mail: r.spooner-hart@uws.edu.au.)

Open Science Index, Agricultural and Biosystems Engineering Vol:8, No:1, 2014 publications.waset.org/9997263.pdf

their dimensions corresponded to the inner surface of the eight or ten frame hive body. Both the tube and mesh bottom boards also had four legs 21cm long, which maintained the treatment hives that distance above the ground surface. The following hive and environmental parameters were measured during the investigation period, which commenced in November 2008 for both sites and concluded in February 2009 for the UWS, and early March 2009 for the Castlemaine sites.

A. Honeybee Flight Activity

To assess flight activity we monitored out-going bees from hives, using a counting cone [16] described by Gary. Two counts were made for a period of 1 min for each hive in a 2h interval from 12:00 to 14:00, every two weeks.

B. Area of Stored Pollen

The area of stored pollen, as an indicator of pollen gathering activity, was determined by image analysis. For this method, the combs from each hive were removed individually and all bees were shaken off the frames. Each frame was then photographed on both sides with a digital camera (Kodak EasyShare C813). The images were then downloaded onto a computer and image analyzing software (Image Pro Plus version 3.0 Media Cybernetics Inc., Bethesda MD, USA) was used to estimate the area within a trace of the outline of the stored pollen in each image. The sum of the pollen areas of all combs in a hive was, thus, the total area of stored pollen for that hive. Data were collected four times at both sites, at four-weeks intervals, started November 24 to February 19, 2009.

C. Area of Sealed Brood

Determination of the sealed brood area, as an indicator of brood rearing activity, was made using the same images of combs used for assessment of the area of stored pollen. In this case, the area of sealed brood in each comb was determined by same technique, i.e. by tracing the outlines of the sealed brood on the image. The sum of the sealed brood areas of all the combs in a hive was regarded as the area of sealed brood for that hive.

D. Honey Production

Each hive was weighed using a digital portable hive scale (Model FS-30KA, A & D Mercury Pty Ltd, Thebarton SA 5031, Australia) to monitor the honey flow into colonies. Hives were weighed monthly during the investigation period and the net weight gain was determined. In situations where frames containing honey were removed from colonies, their total weight was recorded and included with the hive weight, with compensation being made in the calculations for replacement frames. At both sites, data were collected on the same dates as the stored pollen and sealed brood measurements, except at UWS, where no data were collected on January 20, 2009, because of a scale malfunction. Therefore four readings were made at Castlemaine, and three readings were made at UWS.

E. Statistical Analysis

Data were analyzed using Analysis of Variance –General Linear Model (SPSS version 15); where multiple samplings over time were conducted, data were analyzed using the repeated measures general linear model to check for interactions between factors and the time of sampling. If there were no significant interactions between factors and the time of sampling, data were averaged over the sampling time and single analysis was performed. If there was a significant interaction between the factors and sampling time, analysis was separately performed for each sampling time. If significant differences between treatments were detected, their means were separated using Ryan's Q-test if the assumption of equality of variance was met, or Dunnett's T3-test if the assumption of equality of variance was not met.

III. Results and Discussion

A. Honeybee Flight Activity

There were no significant interactions between factor and time of sampling at UWS (P = 0.983) or at the Castlemaine site (P = 0.980), therefore data were pooled over sampling times. Bottom board type did not affect the honeybee flight activity at either the UWS (P = 0.160) or Castlemaine (P = 0.920) sites (Fig. 1).

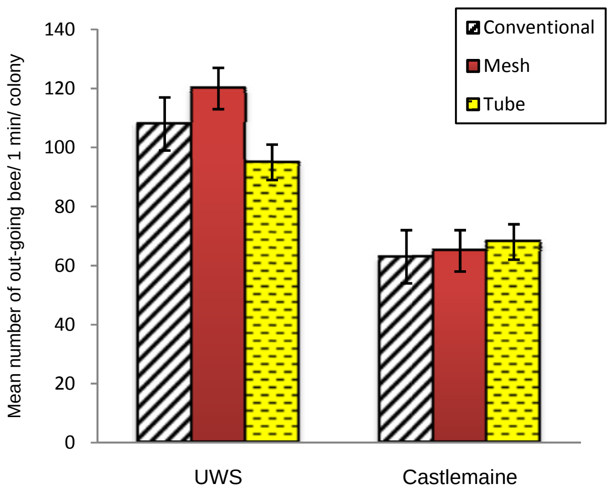

Fig. 1 Mean number of out-going bees/ 1 min/ colony in hives fitted with different bottom boards (Conventional, Mesh, Tube) at UWS and Castlemaine site, 2009

B. Area of Stored Pollen

At the UWS site, the mean pre-treatment areas of stored pollen were 1074.6, 600.8 and 818.7cm^2/colony for hives fitted with conventional, mesh bottom board and tube bottom boards, respectively, showing no significant difference in mean area of stored pollen between hives assigned to different treatments (P = 0.340). Repeated measure analysis of data showed that there was no interaction between time and treatment following imposition of treatments (P = 0.220), therefore data from the three recording dates were pooled. Analysis of variance showed that bottom board type did not affect the area of stored pollen (P = 0.440) (Fig. 2).

At the Castlemaine site, the mean pre-treatment areas of

Open Science Index, Agricultural and Biosystems Engineering Vol:8, No:1, 2014 publications.waset.org/9997263.pdf

stored pollen were 556.6, 553.2 and 479.5 cm^2/colony for the hives fitted with conventional, mesh bottom board and tube bottom boards, respectively, showing no significant difference in mean area of stored pollen in hives assigned to different treatments (P = 0.700). Repeated measure analysis of data showed that there was no interaction between time and treatment following imposition of treatments (P = 0.658), therefore data from the three recording dates were pooled. Analysis of variance showed that bottom board type did not affect the area of stored pollen (P = 0.799) (Fig 2).

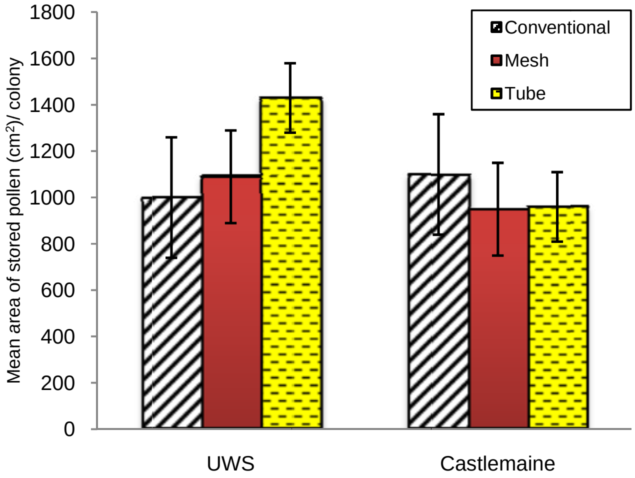

Fig. 2 Mean area of stored pollen (cm^2) in hives fitted with different bottom boards (Conventional, Mesh, Tube) at UWS and Castlemaine site, 2009

C. Area of Sealed brood

At the UWS site, the mean pre-treatment areas of sealed brood were 3077.8, 3320.9 and 2705.3 cm^2/colony for hives fitted with conventional, mesh bottom board and tube bottom boards, respectively, showing no significant difference in mean area of sealed brood in hives assigned to different treatments (P = 0.613). After treatment, there was no significant interaction between time and treatment (P= 0.996), therefore data from the three recording dates were pooled. The imposition of treatments did not result in any significant differences in area of sealed brood (P = 0.231) (Fig. 3).

At the Castlemaine site, the pre-treatment areas of sealed brood were 2974.1, 3165.7 and 3068.8 cm^2 / colony for hives fitted with conventional, mesh bottom board and tube bottom boards, respectively, showing no significant difference in mean area of sealed brood in hives assigned to different treatments (P = 0.883). After treatment, there was no significant interaction between time and treatment (P = 0.148), therefore data from the three recording dates were pooled. The imposition of treatments did not result in any significant differences in area of sealed brood (P = 0.471) (Fig. 3).

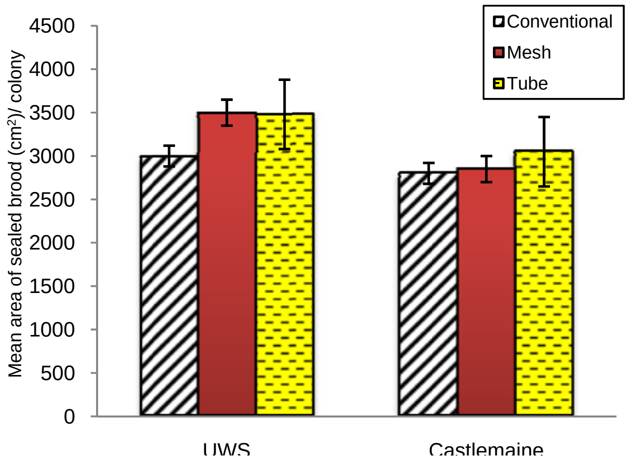

Fig. 3 Mean area of sealed brood (cm^2) in hives fitted with different bottom boards (Conventional, Mesh, Tube) at UWS and Castlemaine site, 2009

D. Honey Production

At the UWS site, mean pre-treatment weights were 58.4, 57.9 and 58.9 kg for hives fitted with conventional, mesh bottom board and tube bottom boards, respectively, showing no significant difference in weight of hives assigned to different treatments (P = 0.831). Following imposition of treatments there were no significant differences in honey production, as determined by change in hive weight (P = 0.080) (Fig. 4).

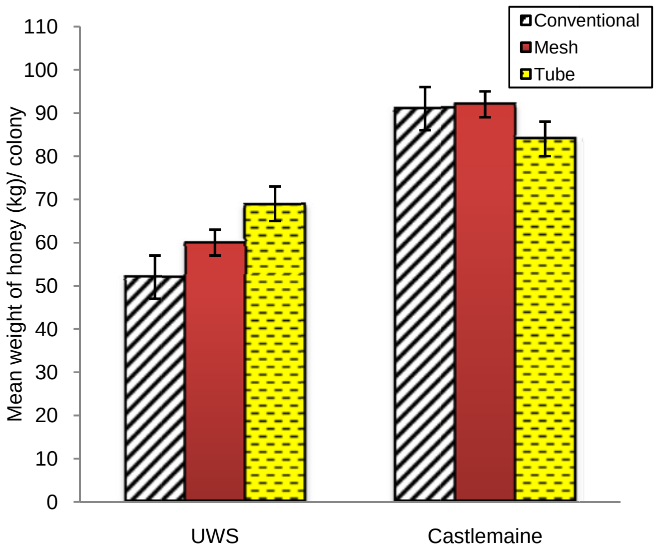

Fig. 4 Mean weight of honey (kg) produced in hives fitted with different bottom boards (Conventional, Mesh, Tube) at UWS and Castlemaine site, 2009

At the Castlemaine site, mean pre-treatment weights were 34.8, 33.4 and 33.4 kg for hives fitted with conventional, mesh bottom board and tube bottom boards, respectively, showing no significant difference in weight of hives assigned to different treatments (P = 0.488). Following imposition of treatments, there were no significant differences in honey

Open Science Index, Agricultural and Biosystems Engineering Vol:8, No:1, 2014 publications.waset.org/9997263.pdf

production (P = 0.065) (Fig. 4).

In conclusion, Bottom board type did not significantly affect any hive production parameter (viz., honeybee flight activity, area of stored pollen, area of sealed brood or honey production). Our results are in consistence with Ellis and Delaplane [12], concluded that bottom board type did not affect any of the colony strength parameters except honey production (i.e. more honey was produced in colonies with conventional wooden bottom boards than screened ones). On the other hand, our results were inconsistence to Pettis and Shimanuki [7] and Coffey [13] who reported that in their study that colonies with mesh bottom boards had significantly more sealed brood than colonies on normal bottom boards. Interestingly, Keshlaf and Spooner-Hart [17] found that bottom board type had apparently influenced the number of in-hive small hive beetles. Tube bottom boards had significantly fewer SHB than the other two treatments, although none of the populations were high, and would not constitute a level likely to impact adversely on hive health.

The trials used eight (UWS) and nine (Castlemaine) replicate hives, which should have been sufficient to identify any major trends resulting from the use of the different bottom boards, and the results were consistent between the two trial sites. However, the data presented are from only one season, and may not represent results which might be achieved under different conditions, or in other locations. The temperatures at the Castlemaine site were atypical, although improved hive ventilation via more open bottom boards is likely to be more beneficial under high temperatures.

Hives fitted with mesh and tube bottom boards were on legs ~ 20cm high. While this may have assisted in improving hive ventilation, it was not reflected in any increase in brood production, pollen storage nor honey production. In addition, the legs made hives with supers more liable to topple over, especially when the apiary site was not on completely level ground. This could be largely overcome with specially-designed pallets to hold and transport hives on legs. A prototype of such a device has already been developed by MrMercader for the tube bottom board. However, it was noted that hive debris was lower in the hives with modified bottom boards, which may reduce feeding and hiding sites for adult SHB. Contrary to some previous reports, there was no evidence of deposition of propolis by colonies on the mesh. Nevertheless, given that there were no conclusive benefits from using either mesh or tube bottom boards (except, possibly, for SHB in the case of tubes) there appears to be no reason for Australian beekeepers to commit to the expense of changing from their current use of solid bottom boards, in the absence of varroa mite. However, in the event that varroa mite does establish in Australia, mesh and/or tube bottom boards may play a useful role in its integrated management. In such circumstances, the data from this project suggest that there will be no detrimental effect to hive development and production if modified bottom boards are used.

It is recommended that, at this stage, further trials with modified bottom boards need to be conducted to assess their benefits in the absence of varroa mite. It is also recommended that Australian beekeepers are made more familiar with mesh and tube bottom boards and their use in varroa mite management.

References

[1] D. Sammataro, U. Gerson, G. Needham "Parasitic mites of honeybees: life history, implications and impact", *Ann. Rev. Entom.* Vol. 45, pp. 519-548, 2000.

[2] Z. Q. Zhang ZQ. "Notes on *Varroa destructor* (Acari: Varroidae) parasitic on honeybees in New Zealand", *Systematic& Applied Acarology Special Publications*, vol. 5, pp. 9-14, 2000.

[3] S. A. Cunningham, F. FitzGibbon, T. A. Heard "The future of pollinators for Australian agriculture"", *Australian Journal of Agricultural Research, vol.* 53, pp. 893 – 900, 2002.

[4] T. Shaibi T, R. F. A. Moritz "10,000 years in isolation? Honeybees (*Apis mellifera*) in Saharan oases", Conservation Genetics, vol. 11, pp. 2085-2089, 2010.

[5] K. Pfefferle "The Varroa bottom board - a movable all-purpose hive floor board", *Allgemeine Deutsche Imkerzeitung*, vol. 14, pp. 236–239,1980.

[6] Anon, "Floors, ekes & inserts: a guide to the construction and use of varroa floors". P.A.M. (eds) Northern Bee Books, Hebden Bridge, UK. 1993.

[7] J. Pettis, H. Shimanuki, "A hive modification to reduce varroa populations", *Amer. Bee J*., vol. 139, pp. 471–473, 1999.

[8] N. Ostiguy, D. Sammataro, J. Finley, M. Frazier, "An integrated approach to manage *Varroa jacobsoni*in honey bee colonies", *American Bee Journal*, vol. 140, pp. 906–907, 2000.

[9] J. Ellis, K. Delaplane, "Efficacy of a bottom screen device, Apistan, and Apilife in controlling *Varroa destructor", Amer. Bee J.*, vol. 141, pp. 813–816, 2001.

[10] D. Sammataro, G. Hoffman, G. Wardell, J. Finley, N Ostiguy, "Testing a combination of control tactics to manage *Varroa destructor* (Acari: Varroidae) population levels in honey bee (Hymenoptera: Apidae) colonies", *International J. of Acarology*, vol. 30, pp. 71–76, 2004.

[11] PJ. Ellis, K. Delaplane, R. Hepburn, P. Elzen, "Efficacy of modified hive entrances and a bottom screen device for controlling *Aethina tumida* (Coleoptera: Nitidulidae) infestations in *Apis mellifera* (Hymenoptera: Apidae) colonies", *J. Econ. Entom.*, vol. 96, 1647–1652. 2003.

[12] J. Ellis, K. Delaplane "The effects of habitat type, Apilife VAR, and screened bottom boards on small hive beetle (*Aethina tumida*) entry into honey bee (*Apis mellifera*) colonies" *Amer. Bee J*., vol. 146, pp. 537-539, 2006.

[13] M. F. Coffey "Biotechnical methods in colony management, and the use of Apiguard and Exomite Apis for the control of the varroa mite (*Varroa destructor*) in Irish honey bee (*Apis mellifera*) colonies", *J. Api. Res.*, vol. 46, pp. 213-219, 2007.

[14] Anon, Trial report on the ''happykeeper'' bottom board, (http://www.beekeeping.com/happykeeper/report_vesoul_2007.pdf) checked on 30 October 2013).

[15] Anon, Trial report on the ''happykeeper'' bottom board, (http://www.beekeeping.com/happykeeper/rapport_11_05_eng.pdf) (checked on 30 October 2013).

[16] N. Gary "A method for evaluating honey bee flight activity at the entrance", *J. Econ. Entom*., vol. 60, pp. 102-106, 1967.

[17] M. Keshlaf, R. Spooner-Hart "Evaluation of Anti-varroa bottom boards for control of small hive beetle (*Aethina tumida*)", In proceedings of International Conference on Agriculturaland Biosystems Engineering, Turkey, vol. 84, pp. 602-606, December 2013.