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# Science behind an Insulated Inner Cover

There have been a lot of articles over the years about Darwinian beekeeping, the best way to mimic the environment of wild hives, and common/traditional ways to minimize stress on managed bees. Since there is nothing natural about keeping bees in wooden boxes, understanding the science is crucial for maintaining healthy hives. Unfortunately, although many articles are based on the science of the wild hive, biology, earth science or physics, many are not, and are based on traditional or non-verifiable anecdotal methods or commonly held beliefs. Without utilizing basic science in hive management, many beekeepers may be stressing their bees instead of helping them which leads to colony failures throughout the year, low winter survival rates, summer losses and reduced honey yields.

The following addresses the concerns and misinformation about both over-wintering, summer management and reducing stress on the colony along with winter feeding using basic biology, physics and earth science; not anecdotal observations.

We will show how insulating the roof of the hive year-round can help with hive survival by minimizing the energy load and maintaining a more uniform colony environment with regard to temperature and humidity; assuming that Varroa is under control since without proper testing and treatment your bees are most likely doomed.

*Basic Science*

- *Bees, like all living beings, need water to metabolize food, proteins, carbohydrates and fats.*
- *Bees need water to thin out honey so it is available for consumption.*
- *Bees like all living beings, need water to survive since they lose water through respiration.*
- *Bees require a humidity level of 60-80% to survive and raise brood.*
- *Bees require water to cool the hive when heat stressed.*
- *Evaporation of water requires heat energy and acts to cool the hive.*
- *Condensation of water vapor creates latent heat.*
- *A frame of honey acts as an insulator and creates thermal mass.*
- *Insulation slows down the transfer of heat, the higher the R-value the better the insulation.*
- *EPS insulation does not break down or absorb moisture over time while many common foam insulation materials lose their R-value rating over time and also absorb moisture.*
- *A hive in the wild in a hollow tree has infinite insulation above the colony and less insulation on the walls, plus a small entrance near the bottom of the colony.*
- *Adding an upper entrance or vent above the colony creates a draft through the hive that removes heat and moisture during the cool weather, plus may redistribute hive odors.*

*WINTER*

- *Bees create a cluster to keep warm and this cluster expands or contracts to maintain a constant interior temperature for the queen and brood.*
- *The cluster moves around the hive consuming honey.*
- *Bees generally start their overwintering in the lower portion of the hive and move upwards as the winter progresses and honey is consumed.*
- *Bees Do Not heat the whole hive, just the cluster.*
- *Heat rises so an insulating board above the inner cover captures and retains the most heat.*
- *Heat from the cluster rises and accumulates under an insulated inner cover to form a heat bubble.*
- *The movement of the warm, moist air creates a micro-climate with warm moisture laden air rising to the top of the hive and then condensing on the walls.*

- *The cluster stays near the center of the hive where it is the warmest.*
- *The coldest part of the hive is the outer walls which are furthest from the cluster.*
- *Moisture condenses on the coldest surfaces. In a hive this is the walls.*
- *Excess hive moisture will condense on the walls, away from the bees and roll down the sides; when enough builds up it will drain out the bottom.*
- *Excess moisture on the outer walls is available for the bees to use to thin out honey.*
- *Any hole in the inner cover acts like a chimney allowing vital heat and humidity to escape while also allowing cold air to enter from the entrance creating a dangerous draft.*
- *A sealed inner cover lets natural convection take place so that the hive temperature and humidity is maintained allowing brood to be effectively raised.*
- *Using an upper entrance creates a chimney which destroys the micro climate.*
- *Anything that disturbs the micro climate within the hive stresses the bees and causes them to expend energy to maintain a uniform colony environment.*
- *Anything that allows heat and/or moisture to escape will destroy the micro climate within the hive; using a quilt board or other absorbent material will dry out both the colony and the brood.*
- *Brood needs to be reared in a high humidity environment so drying out is detrimental.*
- *Mites do not do well in high humidity environments while bees can tolerate high humidity.*
- *Making emergency food available during cold weather is critical for keeping hives alive when the cluster cannot move side to side within the hive to get to stored honey.*
- *Providing food at the center of hive, below the inner cover, allows bee to access it since it is at the top of the heat column in the nest.*
- *Adding an upper entrance hole near the bottom of the upper box allows the creation of a heat bubble and reduces the chimney effect while still allowing bees to get out.*
- *The lower and smaller the hole is in the top box, the more stable the micro climate will be and the less resources that will be needed by the colony.*
- *Anything that retains heat in the hive helps to reduce the consumption of resources; ie. Honey.*

*<u>SUMMER</u>*
- *Bees need to maintain a uniform hive temperature and humidity to raise brood.*
- *Traditional wood covers, with or without metal tops, absorb and radiate heat into the hive.*
- *White covers reflect heat while metal covers absorb heat.*
- *Hives need to be cooled when the temperature rises.*
- *Bees cool the hive by bringing in water and fanning.*
- *Reducing the heat gain with an insulated inner cover reduces the water demand.*
- *Reducing the heat gain with an insulated inner cover reduces the amount of fanning needed.*
- *Reducing the water demand and fanning reduces the energy load on the bees.*
- *An increased energy load from foraging for water for cooling consumes more honey while also reducing nectar foraging for a net loss of stored honey.*
- *An insulated inner cover minimizes the heat gain and allows the hive to maintain a more uniform micro climate; temperature and humidity.*
- *As hives build up and the quantity of bees and brood increase, the hive temperature rises.*
- *As the hive temperature increases, the bees use multiple strategies to cool the hive.*
- *Conversion of nectar to honey generates an excessive amount of moisture.*
- *The faster the bees can remove the excess moisture from the nectar, the fewer cells they need to store nectar before capping.*
- *Freeing up cells means the bees can bring in more nectar and cap more honey.*
- *The combination of insulating the roof and ventilating allows the bees to maintain a more uniform hive environment, with regard to temperature and humidity.*
- *By stabilizing the hive's micro climate there is less stress and a lower energy demand on the hive.*

*<u>Packages/Nucs</u>*
- *Packages and nucs need a stable nest and food to rapidly build comb for the queen to lay.*
- *Bees need to maintain a uniform hive temperature and humidity to raise brood.*

- *Reducing heat loss and maintaining nest humidity allows for a healthy brood.*
- *Direct feeding from the nest insures maximum food update and comb building.*
- *Nipple style feeders through the inner cover hole insure direct access to syrup 24/7.*
- *Indirect feeding from above the nest limits access to syrup since bees need to go into a cold box.*
- *Bees are prone to drowning with feeders that have open syrup.*
- *Open vents and top entrances dry out the hive which stresses young brood.*
- *Open vents and top entrances act as a chimney to cool hive and chill brood.*
- *Maintaining a uniform micro-climate in the nest insures rapid build-up of the colony.*

*Queens*

- *Queens continue to lay eggs continuously from Spring to Fall*
- *Eggs require a fairly tight range of temperature and humidity for survival.*
- *Nurse bees may not raise brood if conditions are not optimal to conserve resources.*
- *Brood issues may be related to environmental issue rather than queen issues.*
- *Reducing heat loss and maintaining nest humidity allows for a healthy brood.*
- *Homeostasis is the key for survivability of brood.*

*Bee Smart Insulated Cover Benefits*

- *The Ultimate Insulated Inner Cover creates a more stable and uniform hive environment which translates into less stress on the bees for healthier hive that conserves resources in both Winter and Summer.*
- *The DUO™ Cover/Insulated Inner Cover System reduces heat gain while retaining nest conditions to help maintain colony homeostasis.*
- *The Ultimate Insulated Inner Cover pairs perfectly with the Ultimate Cover to create a perfect system that works on any 8-frame or 10-frame Langstroth hive.*
- *The Ultimate Insulated Inner Cover is designed to work in conjunction with the Ultimate Direct Feeder for Spring, Fall and Winter feeding, plus fast package and nuc build-up.*
- *The Ultimate Insulated Inner Cover is part of the Bee Smart System that also includes the Ultimate Cover, Ultimate IPM Bottom Board, Ultimate Robbing/Moving Screen with mouse guard and the Super Grip®* Detachable Hive Handle, plus Ultimate Hive Stand.


# Bee Smart Designs

195 Atlantic Avenue, Garden City Park, NY 11040

*(toll free) 800-600-7446 (phone) 516-741-3062 (fax) 516-742-3617*

**info@beesmartdesigns.com**