Maximizing Honey Production and Heating Honey

MISSISSIPPI STATE UNIVERSITY EXTENSION

To maximize honey production from colonies of honey bees (*Apis mellifera* L.), it is necessary to add boxes to hives for receiving incoming nectar during major bloom periods. These boxes are called *supers*, and the addition of supers to hives is known as *supering*. Generally, supering increases the room for honey storage while reducing hive congestion and swarming behavior.

Timing of supering is important. Beekeepers who fail to keep up with the storage needs of a colony lose harvestable honey, especially if the failure to provide space causes a swarming event. About 60 percent of the worker population leaves with a swarm, resulting in a break in brood production for nearly 3 weeks during the transition period when a new queen emerges, mates, and begins to lay eggs. Both of these factors greatly reduce the foraging worker force of a colony, and honey production will be greatly diminished.

Alternatively, putting too many supers onto a colony or adding supers near the end of a honey flow could make a colony vulnerable to comb pests like the small hive beetle (*Aethina tumida*) or the greater wax moth (*Gallaria mellonella*). The vulnerability results from the addition of combs to a colony that has a diminishing worker population in response to reduced availability of food. Brood production is regulated by incoming food, and colonies naturally decrease in population size during the late spring and early summer as food becomes scarce. Shrinking colonies may be stressed if combs are added because there may not be enough bees to patrol and protect the comb surfaces from hive pests.

Hive Location

Supering regimes depend on geographic location because the food plants used by bees vary with location. Honey flows (periods of intense floral bloom) vary substantially from north to south in Mississippi. For example, areas abundant in Chinese tallow trees will often produce honey well into July, while other areas will have finished the major spring flow by mid-May to mid-June. This publication highlights issues related to timing of supering and the numbers of supers to add when supering.

One important point is that honey bees regularly forage for food in a 2-mile radius of their hive, which is about 9,000 acres. Probably the most important consideration in getting a major honey crop is where hives are placed. A good location has an abundance of major nectar- and pollen-producing plants (**Table 1**) during the spring, summer, and autumn periods. Wetlands, urban areas, and rural areas with wildflowers in open prairies and pastures or along roadside shoulders/medians and utility rights-of-way can provide harvestable honey. Avoid areas planted in large acreages of pines or conifers because these are food deserts for honey bees. Some agricultural crops like cotton and soybean can provide harvestable honey in highly agricultural areas like the Mississippi Delta during the summer months.

The second-most important factor in determining your honey crop will be the number of colonies kept together in the same bee yard. Generally, if 30–40 percent of the 9,000 acres that surround a bee yard is covered by major nectar- and/or pollen-producing plants that will bloom during the major spring period, as many as 25–40 colonies could be expected to produce harvestable honey. However, experience may be required to know exactly how much surplus honey can be derived from each hive. Some areas may easily produce 90–100 pounds of surplus honey when 25 colonies are kept in the yard. However, if 60 colonies were placed in the apiary, the honey yield could drop to only 30 pounds per hive. Trial and error may be necessary to determine the best numbers of colonies to maximize resources for a particular location.

A key to knowing when to super your hives is knowing the general bloom periods for the major plants (native and introduced) that provide nectar and pollen for your bees. Nectar is a 25–45 percent sucrose solution produced by flowers to attract pollinators to them. Honey bees convert nectar to honey with the addition of enzymes and evaporation of water. Although pollen is not converted to nectar, it provides the sterols needed to make beeswax combs, and larval honey bees need various nutrients from pollen in their diets. Thus, a key to high honey production is an abundance of both types of incoming food: 1) nectar to be converted into honey and 2) pollen to be converted into new bees that ultimately become foragers or food collectors and new combs for receiving the nectar. The major food plants for honey bees in our state and their bloom periods are provided in **Table 1**.

Generally, the major nectar and pollen plants that bloom from January to mid-March do not contribute to the harvestable honey produced later in the spring and early summer. The reason is that food in late winter and early spring is generally used to grow bee colonies from a low population of 20,000–25,000 bees from the winter cluster to a booming colony of 35,000–60,000 bees needed to take advantage of the primary spring honey flow and produce surplus honey. Although the honey from the flowering plants during this period may not be harvested, it is critically important that these food plants induce rapid colony growth (called spring build-up) ahead of the primary period of spring bloom. Most of the harvestable honey will be produced from nectar-producing plants blooming from April to June. An autumn bloom from late August to November can also provide harvestable honey, but many beekeepers prefer to use the bulk of this autumn honey as food that the bees use to survive the cold winter months.

Supering Hives

This publication does not address all aspects of early-spring management of honey bees in order to maximize honey production. Instead, it is assumed that the reader already understands that producing the highest honey yields per colony requires young and well-mated queens, management schemes to prevent swarming, and placement of hives near flowering plants that produce abundant nectar and pollen. For more information on overall seasonal management and swarm prevention, see MSU Extension Publication 2941 *Colony Growth and Seasonal Management of Honey Bees*. To learn more about considerations for hive placement, see MSU Extension Publication 2937 *Choosing an Apiary Location*.

Quite often, colonies are requeened in the previous autumn so that young queens, which produce strong pheromone signals (which help prevent swarming) and lay eggs at very high rates, are already well-accepted before the onset of a major honey flow. Swarm management can take many forms. Splitting strong colonies to offset crowding is an important strategy. Often making splits involves the delicate balance of taking just enough bees away from a strong colony to deter swarming while not severely hampering the developing foraging worker force. Another important swarm management technique is periodically pulling full honey combs out of the brood chamber and replacing these combs with empty ones. Empty combs give the queen space to lay eggs and keeps the brood nest from becoming honey bound.

Table 1. Important nectar and pollen sources for honey bees in Mississippi.
The following is a list of plants producing nectar and/or pollen for honey bees. Bloom dates for plants in northern Mississippi may be 2–4 weeks later than the same plants in southern Mississippi. Weather patterns may cause bloom times to vary as much as 2 weeks, but the succession of blooming plants listed below should be correct in most years. Some of the less important food plants have been omitted. Those plants blooming in January, February, and March are significant because they supply early nectar or pollen, which is used for brood production and spring build-up; not necessarily for surplus honey that will be harvested.

Common name	Genus and/or species	North Mississippi approximate bloom date	South Mississippi approximate bloom date	N = nectar P = pollen
hazel alder tag alder	*Alnus serrulata*	Late Jan–Feb	Jan 5–Feb 15	P
red maple	*Acer rubrum*	Feb 1–Mar 10	Jan 25–Feb 15	N/P
henbit	*Lamium* (2 sp.)	Feb 1–Mar 15	Jan 20–Mar 1	N/P
wild mustard	*Brassica kaber*	Mar 10–Mar 30	Mar 1–Mar 20	N/P
eastern redbud	*Cercis canadensis*	Mar 10–Mar 31	Feb 15–Mar 15	N/P
elm	*Ulmus* sp.	Feb 15–Mar 1	Jan 15–Feb 5	P
spring titi* black titi buckwheat tree	*Cliftonia monophylla*	not present	Feb 15–April 10	N/P
fruit bloom	apple, pear, etc.	Mar 1–Mar 30	Feb 15–Mar 15	N/P
willow	*Salix* sp.	Mar 25–Apr 10	Mar 10–Mar 30	N/P
Hawthorne	*Crataegus* sp.	very little	Mar 15–Mar 30	N/P
springbeauty Virginia springbeauty	*Claytonia virginica*	Mar 10–Mar 25	Mar 1–Mar 20	N/P
white clover*	*Trifolium repens*	Mar 10–June 30	Mar 1–June 30	N/P
crimson clover	*Trifolium incarnatum*	Mar 15–Mar 30	Mar 1–Mar 15	N/P
blackberry*	*Rubus* sp.	Mar 15–Apr 30	Mar 5–Apr 20	N/P
hairy vetch* winter vetch	*Vicia villosa*	Mar 25–Apr 30	Mar 15–Apr 15	N/P

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Common name	Genus and/or species	North Mississippi approximate bloom date	South Mississippi approximate bloom date	N = nectar P = pollen
wild plum	*Prunus* sp.	Mar 25–Apr 10	Mar 15–Mar 30	N/P
huckleberry	*Gaylussacia* sp.	early April	Mar 20–Apr 25	N/P
wild cherry	*Prunus* sp.	Apr 1–Apr 15	Mar 20–Apr 10	N/P
sweet gum	*Liquidambar* sp.	Apr 10–Apr 25	Mar 25–Apr 10	P
black locust*	*Robinia pseudoacacia*	Apr 10–Apr 20	Apr 5–Apr 15	N/P
tupelo gum water or swamp tupelo	*Nyssa* sp.	Mar 20–Apr 15	Mar 10–Apr 30	N/P
black gum black tupelo	*Nyssa sylvatica*	Apr 20–May 5	Apr 10–May 1	N/P
tulip or yellow poplar*	*Liriodendron tulipifera*	Apr 20–May 10	Apr 5–Apr 25	N/P
highbush gallberry*	*Ilex coriacae*	not present	Apr 5–Apr 25	N/P
American holly	*Ilex opaca*	Apr 20–May 10	Apr 5–Apr 15	N/P
yaupon holly*	*Ilex vomitoria*	Apr 25–May 15	Apr 5–Apr 15	N/P
American persimmon	*Diospyros virginiana*	Apr 25–May 10	May 1–May 10	N/P
Chinese privet*	*Ligustrum sinense*	May 1–May 15	Apr 10–Apr 25	N/P
sabal or palm palmetto	*Sabal palmetto*	May 1–June 1	Apr 15–May 15	N/P
rattan vine* Alabama supplejack crossvine	*Berchemia scandens*	May 1–May 20	Apr 10–Apr 25	N/P
low bush gallberry*	*Ilex glabra*	not present	May 5–May 20	N/P
common milkweed	*Asclepias syriaca*	May 10–May 21	Apr 15 – Apr 30	N/P
poison ivy	*Toxicodendron radicans*	May 15–May 30	Apr 25–May 10	N/P
poison oak	*Toxicodendron oubescens*	May 15–May 30	Apr 25–May 10	N/P
sumac*	*Rhus* sp.	June 1–July 10	June 20–Aug 30	N/P
summer titi*† ironwood	*Cyrilla racemiflora*	not present	June 1–June 30	N/P
sourwood*	*Oxydendrum arboreum*	June 1–July 15	little present	N/P
Chinese tallow* popcorn tree	*Triadica sebifera*	June 1–June 20	June 10–June 30	N
upland cotton*	*Gossypium hirsutum*	June–Aug	June–Aug	N/P
peppervine*	*Ampelopsis* sp.	June 15–July 30	June–July 30	N/P
coastal sweetpepperbush	*Clethra alnifolia*	not present	June 30–July 30	N/P
blue vervain* swamp vervain	*Verbena hastata*	June 15–August	July–Sept	N/P
knotweed or smartweed	*Polygonum* sp.	July–Sept	not known	N/P
soybean*	*Glycine max*	July 1–Aug 31	does not produce	N/P
redvine	*Brunnichia ovata*	July 15- Aug 15	July 1–July 30	N
goldenrod*	*Solidago* sp.	Aug 25–Sept 30	Oct 1–Oct 30	N/P
white boneset*	*Eupatorium serotinum*	Aug 25–Sept 15	not known	N/p
Spanish needle	*Bidens alba*	Sept 1–Sept 30	not known	N/P
beggarslice (ticks)*	*Hackelia virginiana*	Sept 1–Sept 30	not known	N/P
asters*	*Aster* sp.	Sept 20–frost	Oct 5–frost	N/P
eastern smokebush* sea myrtle groundsel bush	*Baccharis halmifolia*	Sept 20–Oct 10	Oct 10–Oct 30	N/P

*Indicates that a surplus of honey may be produced if environmental conditions are right.
†Toxic. Causes purple brood.

Staying ahead of a hive's storage needs is the trick to obtain high yields. Well-established beekeepers will super with boxes containing drawn and empty combs, while new beekeepers may only have undrawn frames of foundation to place in the honey supers. Obviously, honey bees can store more nectar and store it faster if they do not have to produce combs from foundation. It probably requires energetically about 25 pounds of honey to draw out 10 medium combs of foundation. The wax used to make combs also taps into the nutrition of a colony because the wax is derived from the sterols and fatty acids found in pollen. Producing high amounts of wax drains some of the nutritional components from pollen that are also used to feed bee larvae. Hence, wax production can slow brood production.

Our discussion of supering will begin with a hive conformation in which the brood chamber consists of two deep boxes and the honey supers to be added will be medium boxes (**Figure 1**). There are many different styles of hive management, so try not to focus on the actual hive units; focus more on the additions to the base unit with supering. Additionally, the debate over the utility of a queen excluder to separate honey supers from the brood nest will not be discussed here. The device is designed to restrict the queen from moving into honey supers to lay eggs. Some beekeepers use excluders, and some do not. It is a matter of personal choice. For those who use queen excluders, it is imperative to remove the device at the time of harvest. Too many new beekeepers forget and leave the excluders on the hive well into the winter. This mistake can lead to the death of a queen and eventual demise of the colony during the winter months.

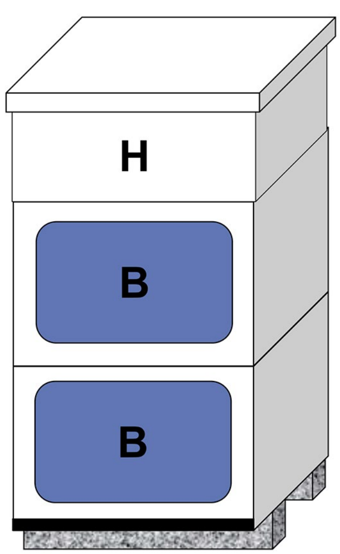

Figure 1. Starting hive with brood chamber in two deep boxes and the first honey super already on top of the hive. Supering rule of thumb: when two-thirds of the combs are nearly full of honey and being capped, the next super(s) should be added.

Our starting point assumes that our colony has survived the often-difficult months of January to March when unsettled weather can interrupt periods of good weather that permits foraging for pollen and nectar. Our queen is laying eggs well, and our bee colony has grown to completely cover at least 10–12 deep combs. Additionally, a honey flow has begun, and the bees have completely filled 6 out of 10 combs in the honey super. The bees have begun capping ripened honey in many of these combs. It is definitely time to super while it is still early in the season, but how many supers should be added?

The number of supers to add is really a question of proximity to the peak of the main springtime flow. Experienced beekeepers know the rate of honey accumulation associated with a typical spring in their geographic area, and they often gauge when and how many supers to add based on the progress of the bloom. If that first honey super of our starting hive is filling, and the peak bloom is weeks away, perhaps more than one super can be added (**Figure 2**). At least two supers could be placed on the hive, and in areas with extremely prolific nectar-producing plants, perhaps even more than two supers could be added.

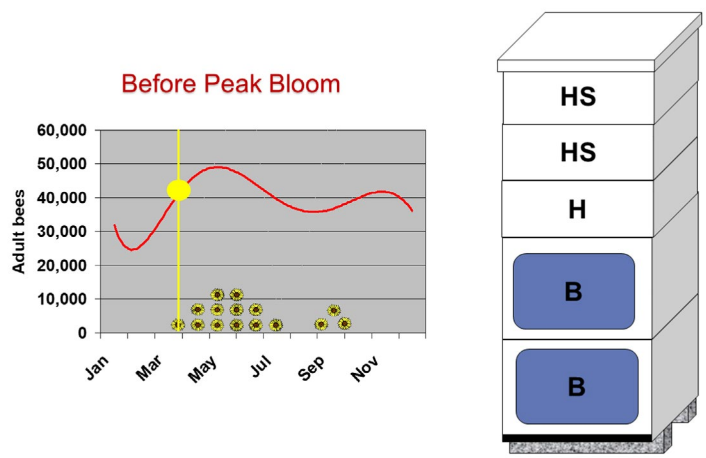

Figure 2. Multiple supers can be added during a single supering event if space is needed before the peak of the traditional spring bloom. The added honey supers are labeled HS, while the already full or filling super is labeled H.

Another frequent question is, "How should supers be added—above or below the existing almost full or filling super(s)?" Top supering refers to placing the new boxes above the nearly full super of honey, while bottom supering is placing the empty supers beneath the full box of honey. There seems to be an endless debate about which of these techniques yields the most honey, but there is little published scientific evidence that one method is better than the other. Therefore, it becomes a matter of personal choice. Significantly less lifting of heavy boxes of honey is involved with top supering, which is why people with hundreds to thousands of hives prefer that technique.

As always, a primary concern with adding empty combs to a colony of bees is whether that space will be adequately protected by the bees to prevent oviposition by small hive beetles or greater wax moths. This is rarely a problem for strong and growing colonies when the peak of spring bloom is yet to occur. Strong colonies will be able to patrol the added space. Of course, adding two empty boxes of comb to a colony of bees during the summer dearth could be a disaster. Colonies naturally decline in size during a dearth of incoming food, and it is likely that much added space will stress the bees and allow comb pests to get a foothold in the hive.

Suppose our starting unit (**Figure 1**) that needs supering is actually found at the peak of our main springtime honey flow. Should we super at all? Can the hive take multiple supers? There are no hard and fast rules here, but generally, supering will be required, and more caution asks us to use perhaps only a single empty super at this time (**Figure 3**). As in the previous scenario, the number of supers added depends on proximity to the peak bloom, but it also depends on the nectar-producing plants. In Starkville (northeast Mississippi), the main spring flow depends on privet and clovers. These are prolific nectar producers; however, they are not at the same level of production as Chinese tallow. If supering is required at peak flow in Starkville, the addition of one box may be adequate given that there may be only few days to a week left in the main pulse of bloom. However, someone in a heavy Chinese tallow area (e.g., Jackson, Mississippi) may choose to add multiple supers even when they suspect that they are already at the peak of the honey flow.

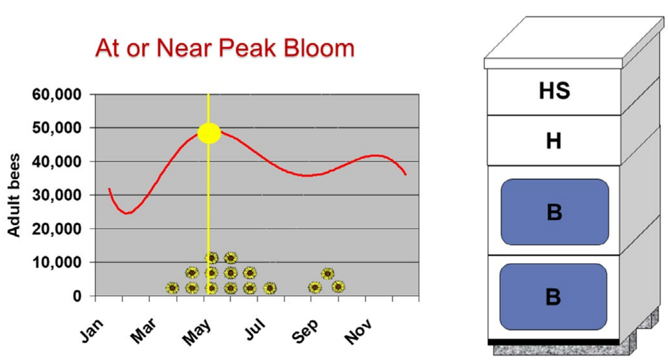

Figure 3. Generally, only a single super will be added during a single supering event if it occurs at the peak of bloom.

As is typical of any beekeeping situation, there is always a gray area. Your starting unit (**Figure 1**) may be found after the peak of the primary spring flow but perhaps days to weeks before a well-defined dearth of bloom that marks the beginning of summer in some places. Does it need a super? In a typical year, supering after the peak of the spring bloom is not required in Starkville because the nectar availability drops rapidly. Additionally, the brood nest constricts as the queen's egg production slows, and the bees begin to back-fill the brood nest with incoming nectar (**Figure 4**). That freed up space in the brood nest is usually adequate for receiving the last nectar of the ending spring flow. The colony will not feel congested, and the threat of swarming has long passed.

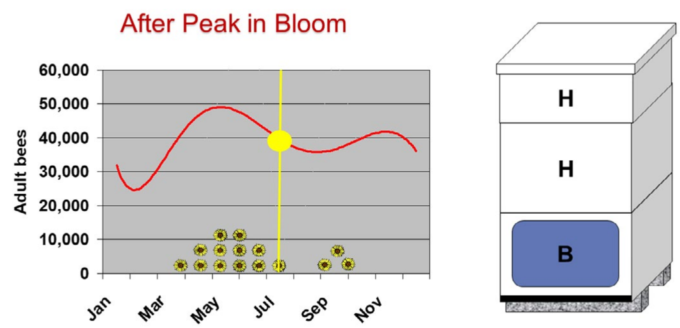

Figure 4. Supering is usually not necessary if the colony has a nearly full super after the peak of bloom. In a typical summer, the brood nest constricts and the nectar from the declining spring flow will be stored in the brood nest.

Heating Harvested Honey

If all goes well, most beekeepers will harvest significant surplus spring honey by the beginning to middle of July. It is assumed that even the smallest beekeepers know how to remove honey supers from the hive, uncap combs, centrifuge combs, strain their honey, and eventually bottle it to sell (**Figure 5**).

The most important consideration for handling honey is the question of heating to protect it from fermentation. Honey contains spores from sugar-tolerant yeasts that can be activated by moisture in the honey. The yeasts will ferment the honey and produce a souring flavor and some alcohol in the honey. Purposeful fermentation is done to make mead, which is one of the oldest alcoholic beverages in human history. The incidental and uncontrolled fermentation of honey produces a bad-tasting product that consumers will find undesirable; therefore, many producers of large amounts of honey heat it to kill the spores of the yeast that could spoil their product.

The fermentation activity of the sugar-tolerant yeasts can also be stopped by storing honey below 50°F. However, cold storage does not kill the yeasts, and they will become active again when the temperature increases. The only sure way to kill yeasts is by heating the honey.

Some people who never heat honey will admonish those who do heat their honey. They claim that health

Figure 5. MSU summer beekeeping camp participant Fritz Fulgham uncaps ripened honey before centrifuging the combs in a small extractor to sling the honey from the combs. Most small beekeepers will strain the centrifuged honey through a series of filters before it is allowed to settle for days to weeks. Debris like pollen and insect body parts will rise with air bubbles to the top of settled honey, which allows for a cleaner product to be dispensed for bottling by the honey gate at the bottom of storage tanks or buckets.

benefits of completely "raw" honey are much better than pasteurized honey. It is important to note that there has been no universal agreement on what legally defines raw honey. Additionally, some proponents of not heating honey claim that much of the anti-microbial activity is lost in heated honey because of degradation of enzymes like glucose oxidase. Perhaps some anti-microbial activity is lost, but certainly not all. Much of the anti-microbial activity of honey comes from the high sugar concentration (an osmotic effect), a low or acidic pH, and, in some honey, the existence of antibacterial compounds like methyl glyoxal (e.g., manuka honey). Gentle heating does not destroy these characteristics.

Large producers heat honey to kill yeast that could ultimately ferment the honey during storage before bottling, or even in jars on the store shelf. The reasons are simple. All honey contains spores of sugar-tolerant yeasts that will become active when the water content is above 17 percent. The typical spring honey in Starkville is around 18 percent moisture, which increases the chance of fermentation. However, the rate of fermentation is determined by the relative spore count of yeasts and the percentage of water content in the honey (**Table 2**).

Table 2. The fermentation rate of honey is related to the moisture content of the honey and the relative yeast spore count within the honey. Most people do not have a way to measure the spore count in their honey, but it is safe to assume that it is greater than 1 spore per gram. Therefore, honey with a high moisture content (19 percent) will eventually ferment during storage. Source: White (1992).

Moisture Content (%)	Tendency to Ferment
< 17.1	Safe, regardless of yeast count
17.1–18.0	Safe if yeast count is < 1,000 per gram
18.1–19.0	Safe if yeast count is < 10 per gram
19.1–20.0	Safe if yeast count is < 1 per gram
> 20.0	Always in danger

Wetter honey will ferment faster because the actual number of spores needed per gram of honey to trigger fermentation becomes lower with wet honey. For example, a moisture content of 19 percent will trigger fermentation if the yeast spore count is only 1 spore per gram of honey (**Table 2**). Most honey has more than 1 spore per gram; therefore, it is not a matter of *if* wet honey will ferment, but *when* it will ferment. Small producers who choose not to heat honey tend to sell in small jars so that their customers consume the honey before it has a chance to ferment. Many reduce the moisture content of the honey by dehumidifying chambers containing the honey, but honey is quick to regain moisture from the air in humid environments—even in sealed jars.

The safest course for most commercial beekeepers or other producers of large quantities of honey is to gently heat their honey to kill the spores of yeast (see **Table 3**). Once killed, variation in the moisture content of the honey will not trigger fermentation. Many producers like to dehumidify chambers and dry their honey before selling it as well, but the heat treatment is what protects the honey during storage.

Table 3. Heating regimes for killing yeast spores in honey. Most commercial beekeepers never heat their honey above 125°F to avoid any significant harm to the honey. Source: White (1992).

Temperature (F)	Minutes
125	470
130	170
135	60
140	22
145	7.5
150	2.8
155	1.0

What is gentle heating? Most commercial producers like to heat honey to only 120–125°F during the processing before bottling. Significant damage to honey occurs above 150°F, and commercial honey producers do not want a product that has charred and degraded sugars and other degraded components. Some small producers can quickly heat 15 gallons of honey in a small bottling tank (**Figure 6**). The MSU apiculture program often heats honey to 135°F for an hour to kill yeast. The resulting honey has no off-putting flavors (e.g., caramelized or charred sugars) or other distasteful qualities.

Some people believe heating honey at all destroys aroma, taste, or other qualities, but unheated honey is in peril of fermentation if the moisture content is higher than 17 percent. Most honey in Mississippi exceeds this limit. Commercial beekeepers earning a large income from honey sales cannot risk fermentation. The best compromise is to heat honey at a low temperature to kill yeast and minimize any thermal damage.

How can small beekeepers who cannot afford an expensive stainless-steel bottling tank heat honey to kill yeasts? The traditional use of a stovetop water bath works well for small glass jars of honey: Fill a medium-sized sauce pan with water and bring it to a near boil. Place the jars of honey in the pan without lids or tops; stir frequently during the process. Use a candy thermometer to measure the temperature of the honey; try to keep the honey at 135°F for an hour before letting it cool. A cooler temperature can be used, but the time on the stove may be uncomfortably long for most people.

Another option is to build a heating chamber into which 5-gallon buckets or other large volumes of honey can be placed. Some beekeepers modify old refrigerator-freezers or build insulated wooden boxes that are heated with high-wattage heat lamps. Link the electrical circuit for the lamps to a thermostat or double thermostat set to 120–125°F, and heat the honey for several hours with frequent stirring to kill yeasts. It is a good idea to have a circulating fan inside the chamber to help move air in the box to ensure even heating.

Finally, it is not a good idea to use a microwave oven to heat honey. Honey heated even for just 30 seconds in a microwave oven can become super-heated, causing significant damage to the sugars and other components of the honey. Additionally, handling a jar of super-heated honey can cause severe burns.

Figure 6. Jill Phillips bottles honey from a 15-gallon bottling tank that MSU Apiculture uses to heat honey at 135°F for an hour to kill the yeast.

Summary

- Locate hives near abundant blooming plants throughout the entire year.
- Keep a minimal number of hives at any one location.
- Young queens lay more eggs and grow larger worker bee populations that are needed to forage for food and produce honey.
- Swarm prevention is essential for highest honey yields.
- When 6 out of 10 combs in a honey super are full and being capped, it may be time to add another super.
- Add supers based on the amount of incoming nectar normally expected during the next few weeks of bloom.
- If supering occurs before peak bloom, multiple supers can be added.
- If supering after the peak bloom, you may need only one additional super or even no supers if it is very late in the season.
- All honey contains sugar-tolerant yeast that cause fermentation, which can sour stored honey and make it unpalatable.
- The rate of fermentation depends on the number of spores of yeast and the percentage water content in the honey.
- Gently heating honey is the only sure way to kill yeasts that cause fermentation.
- Most commercial beekeepers heat honey for several hours at 120–125°F to kill yeasts. This treatment does not significantly harm the flavor or antiseptic properties of honey.

Reference

White, Jr., J. W. (1992). Honey. In J. M. Graham (Ed.), *The hive and the honey bee* (869–925). Hamilton, IL: Dadant & Sons.

Publication 3382 (POD-09-19)

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