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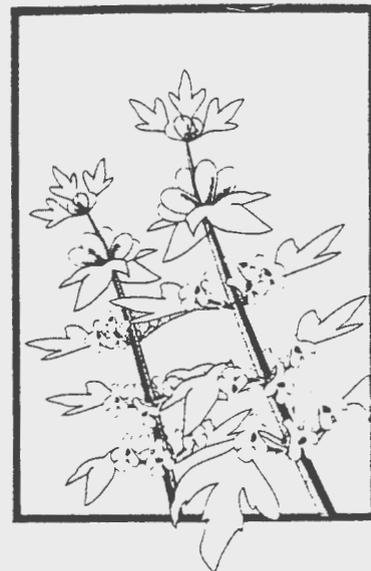
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The Other Side of BEEKEEPING

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The Genus Agastache as Bee Forage: An Analysis of Reader Returns¹

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INTRODUCTION

In the May column, we reviewed published reports on the genus *Agastache*³ as bee forage and came to two somewhat contradictory conclusions:

1. The data support the contention that under proper circumstances several species of *Agastache* can be exceptional bee forage. These data came from observations made on both wild (Pellett, 1926; Vansell, 1933; and Wilson et al., 1958) and cultivated plants (Terry, 1872; Pellett, 1943 and 1946; and Mayer et al., 1982).

2. Despite *Agastache*'s potential productivity and the fact that there were two historical periods in which one or more members of the genus were culti-

vated for bee forage, the beekeeping literature is almost totally devoid of data, or even of testimony, derived from large-scale plantings. The major exception to this statement is a short paper by Mayer et al. (1982) where the estimated honey production of Washington beekeeper John Eckstrom suggested that more than a ton of honey could be produced from an acre of land planted to *Agastache foeniculum* (Pursh) O. Kuntze.

To help reconcile the differences between the plants' potential productivity and lack of large scale tests, the September-92 and January-93 "Other Side of Beekeeping" requested reader input concerning experiences with anise hyssop. In this article, we examine more than twenty responses from these requests, augmented by responses from five individuals we queried personally, inferences made from our literature review, and our personal experiences with the genus, to speculate on reasons for the apparent discrepancy.

The responses indicate that there is no single problem that has prevented profitable land-based honey production from *Agastache*. Instead, we have categorized seven major problem areas encountered by those who have attempted raising *Agastache* for bee forage.

1. Insufficient planting size
2. Establishment problems
3. Competition with weeds
4. Poor adaptation
5. Diseases and pests
6. Unattractiveness to honey bees
7. Competition from other beekeepers

In the remainder of this article, we examine each of these in turn.

Insufficient Planting Size

The returns indicate that many beekeepers enjoy their small bee forage plantings. Although we encourage beekeepers to continue this enjoyment, from a honey production standpoint, a planting does not become profitable until it has reached a size much larger than those of nearly all the beekeepers who responded with information. Fig. 1 illustrates the planting areas needed to produce different amounts of honey for honey potentials of 1000 and 2000 lbs per acre. In this figure, area is represented on the horizontal axis by the length of one side of a square planting. In this way, an acre is represented by a square planting 208.7 ft on a side. The 1000 lbs per acre honey potential is based on nectar production estimates from exceptional bee forage species (see this

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³ In this article, the term anise hyssop refers to *Agastache foeniculum* (Pursh) O. Kuntze specifically whereas the term *Agastache* implies that other species may be involved.

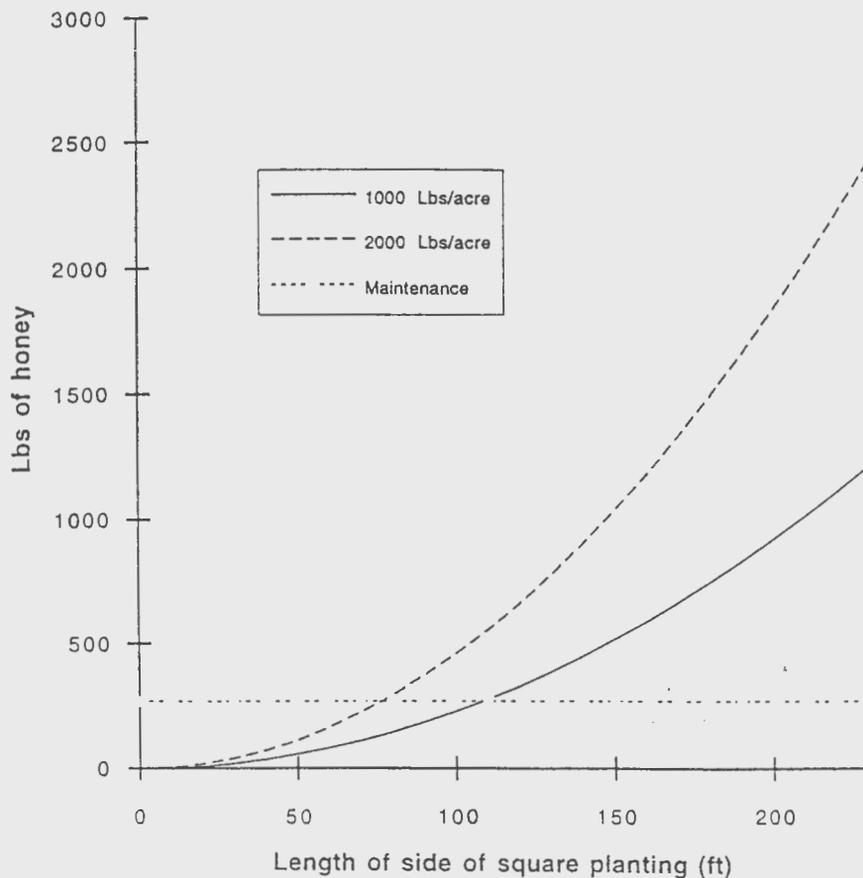


Figure 1 - Potential honey production from different size plantings using 1000 and 2000 lb/acre honey potentials. To facilitate visualization of the size of the hypothetical plantings, planting size is represented by the length of one side of a square planting. The horizontal line represents our estimate of the maintenance needs of three colonies over a 30 day period (see text).

column September-92) and the 2000 lbs per acre figure is based on estimates provided in Mayer et al. (1982). We believe that the 1000 lbs/acre estimate is the more realistic of the two and even this has a great deal of uncertainty attached to it. Because it is based on total nectar production, it does not account for the maintenance needs of the hive, including the number of honey equivalents used for foraging, brood rearing, hive temperature control, etc. How large is this maintenance requirement? As a conservative estimate, consider how much weight hives lose when there is little or no nectar flow during the summer. In these periods, the bees are doing much of what they would during a honey flow such as rearing brood, flying, and regulating temperature, but there is no food coming into the hive. Visscher and Seeley (1982) report a maximum daily weight loss of approximately 2 lbs for a small colony during poor climatic conditions in early September near Cayuta, NY. Thompson (1960) reports a maximal daily weight loss for early April in southwestern Arkansas of nearly two lbs. These data suggest that hive maintenance costs are approximately 2 lbs/day.

We suspect that this estimate is a little low because some of the hive's energy-using activities may be reduced during periods of poor nectar flow, and also because small amounts of nectar may still be entering the hive unnoticed. We therefore propose a 3 lb daily maintenance cost for purposes of illustration. Now, let us suppose there are three hives foraging on a hypothetical planting, and that anise hyssop remains at peak bloom for 30 days (see Fig. 2). That works out to 3 lbs of honey X 30 days X 3 hives or 270 lbs of honey that the planting must provide before the beekeeper sees any honey accumulation from the planting. By referring to Fig. 1, it becomes clear that a planting with three hives of bees would not become productive until it has an area equal to that of a square approximately 100 ft on an edge (0.23 acres). Remember also that, in the example just provided, any honey accumulation must be divided among three hives, so that the planting must be somewhat larger than this 100 ft square if the beekeeper is to be certain that what appears to be excess production is not simply the result of normal yearly production fluctuations.

Of the returns we received, only two had clearly made plantings equivalent to, or larger than, our hypothetical 100 ft square planting. The largest was approximately two acres.

Establishment Problems

Agastache seed is quite small (between 50,000 and 150,000 seeds/ounce). With its limited energy reserves, it can successfully germinate only under a light soil covering and should therefore be planted either very near to, or actually on, the soil surface. Because soil very near the surface can dry quickly, seeds planted there either do not germinate because of dryness, or, if they do germinate, are at risk from desiccation before they develop a substantial root system to reach water. This postgermination desiccation is made more serious by the species' slow initial growth.

Widrechner (1988) reported 0 to 50% (mean=22%) germination for nine samples of *Agastache*, including *A. foeniculum*, *nepetoides*, and *rugosa*. In that study, pre-counted samples were planted on the soil surface, covered with a thin layer of fine vermiculite, and held under somewhat controlled conditions in a greenhouse mist bench. These samples were obtained from a variety of sources (botanical gardens, seed companies, and individuals) so their storage history and seed quality were unknown prior to planting.

In a routine test of freshly harvested seed samples of *Agastache* produced at the North Central Regional Plant Introduction Station, germination rates ranged from 40 to 92%, when tested in blotter boxes placed under alternating temperatures of 68/86°F and a 16-hour photoperiod, following an initial treatment of seven days of moist chilling at 40°F. There are numerous reports [reviewed in Ellis et al. (1985)] of seeds of mint-family plants requiring moist prechilling, light, and/or alternating temperatures for optimal germination. Beekeepers' experiences with poor germination may result either from poor initial seed quality or from less than ideal germination conditions.

Frank Pellett experienced germination problems in his early attempts to establish *A. foeniculum* in the *American Bee Journal's* Honey Plant Test Garden (F. Pellett, 1940). From comments made largely by his son Melvin in discussions about anise hyssop (M. Pellett 1956 and 1965), it is clear that many to whom Pellett Gardens provided seed experienced similar problems.

Most of our respondents attempted to improve establishment by transplanting seedlings started in flats. Even so, a few experienced difficulty with seed germination. Transplanting was feasible in most cases because the plantings were quite small, but for larger plantings of an acre or

more, sowing seed directly into the field would be advantageous because most beekeepers neither have the facilities to raise tens of thousands of plants for transplanting, nor the equipment to transplant them. Direct seeding was, however, not always a failure and three respondents indicated that they had been successful in the practice. In one case, direct seeding was accomplished by removing the dried plant material from an established planting in the fall and spreading it in a second location. Two respondents indicated that anise hyssop sometimes self-seeds after establishment and can become a weed in a garden.

Weed Competition

Because of its initial slow growth, anise hyssop competes poorly with faster growing annual weeds such as lamb's-quarters and pigweed or with aggressive perennials such as quackgrass or brambles. Only two respondents, however, indicated that weeds were a serious problem in *Agastache* plantings. One of these has actually developed strategies for weed control which we will discuss in more detail in the September issue. We undoubtedly did not receive more responses indicating weeds were a problem because most plantings were so small that they could be hand-weeded with little difficulty. It is unclear how the two large plantings were weeded. We suspect that some type of mechanical weeding was used. In our opinion, weed control during at least the first year of field establishment is critical. One of our contacts (not a respondent) indicated that anise hyssop becomes quite competitive by about the end of its second year in the field. This is

basically our experience at both Michigan State University and at the North Central Regional Plant Introduction Station. One response from North Carolina, however, indicated that weeds remained a problem even after the initial year. Conversations with William Lord, who established an experimental planting at North Carolina State University (Lord, 1983), indicated similar problems. In both cases, the planting had been weeded for the first year, and then became overrun with weeds during the second year. Perhaps since *A. foeniculum*, which probably was planted in both cases, originates from the Northern Plains, it is noncompetitive relative to local weeds under more southern conditions.

Poor Adaptation

Beekeepers who plant anise hyssop in sites that differ greatly from its typical natural habitat can experience problems from poor plant adaptation. During travels through the Northern Great Plains, the junior author has observed anise hyssop thriving in sun to light shade on soils that retain moisture, but are not excessively wet. The typical climate of this region is one of warm to hot summers with low to moderate relative humidity and irregular rainfall and of cold winters, often with persistent snow cover. The daylength usually exceeds 15 hours during the summer. In the greenhouse, we see improved flowering when the photoperiod is artificially lengthened.

To our knowledge, neither Frank nor Melvin Pellett reported problems with long-term survival of anise hyssop when cultivated in western Iowa. Our reports from beekeepers in the Upper Midwest, in

or near the species range, often note its persistence. One approximately 400 ft² patch at Michigan State University will start its 6th year during 1994. Previously, it has always formed a nearly solid stand and there is no reason to suspect that it will do otherwise during 1994.

We should note two general concerns related to adaptation. First, as a probable adaptation to drought, anise hyssop produces fewer flowers in dry summers, making irrigation a necessity for good nectar production in arid regions (Mayer et al., 1982). Second, beekeepers from Maine, Michigan, Virginia, and California reported overwintering losses or short-lived populations. These areas may experience mild, moist fall weather that could interfere with winter hardening. Alternatively, these beekeepers may have been cultivating Korean mint which is often short-lived (2-3 years at both Ames and East Lansing), or perhaps their plants suffered pre-disposition to winter injury from stresses caused by diseases or other pests.

Diseases and Other Pests

Few insect pests on anise hyssop have been observed in Iowa. In Michigan the fourlined plant bug [*Poecilocapsus lineatus* (Fabr.)] can be devastating to plants prior to flowering. The symptoms are much like that of a disease; the leaves curl and turn black and the plant appears to be dying. These symptoms can occur with even very light infestations and for this reason the problem was originally misdiagnosed as a disease. Insecticides that are effective against fourlined plant bug bring about a remarkable recovery. This pest has been found to be a pest of nearly every

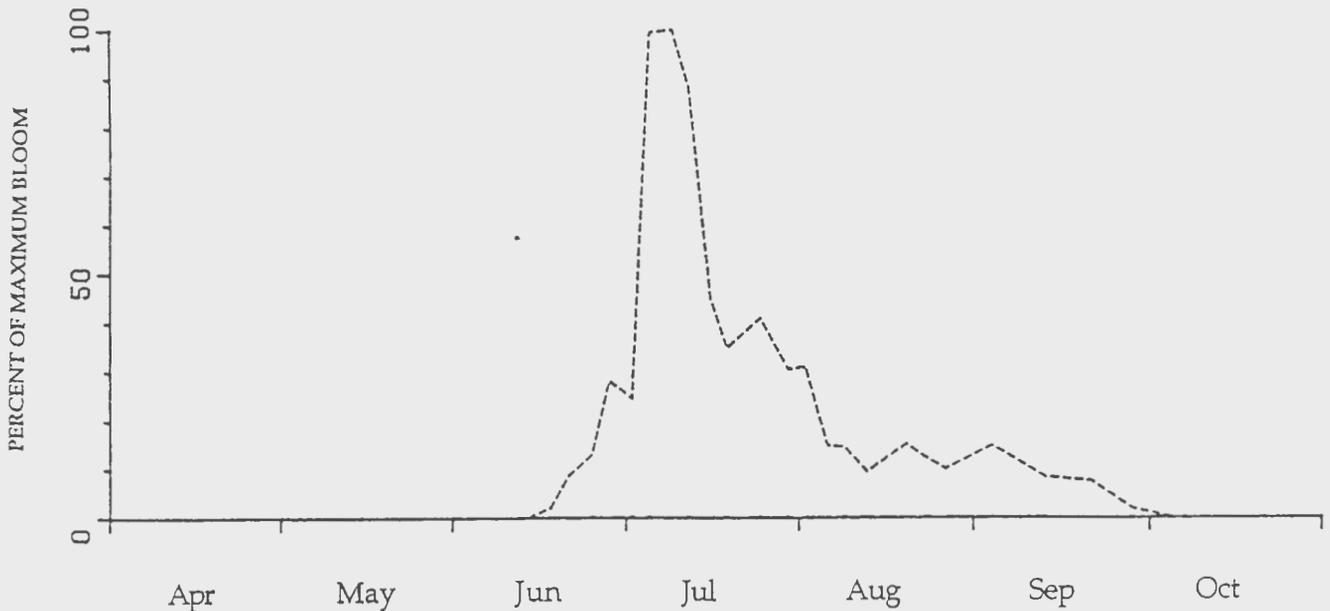


Figure 2 - Flowering curve of anise hyssop showing a duration of peak bloom of approximately 30 days. Notice that the plant blooms at a lesser intensity over a prolonged period of time. Data from Ayers et al. (1987)

mint that has been tested in the Michigan State University bee forage project. Large populations of true bugs in the family Miridae have been noticed in the flower spikes at both the Plant Introduction Station and Michigan State University. It is possible that these populations reduce seed production. Anise hyssop is so prolific they have, as yet, produced no serious problems. A beekeeper in North Carolina observed feeding by Japanese beetles, but this was not noted by other respondents from the east. Slug damage was noted in New York and nematodes were originally thought to have killed a plot in Oklahoma; but this is doubtful because the site was then treated to control nematodes yet the die-out reoccurred the next year.

Reports of fungal diseases on *Agastache* have been summarized by the USDA (1960) and by Farr et al. (1989). The fungi reported therein generally do not cause serious damage to anise hyssop, although under high humidity, leaf diseases, such as mildews and leaf spots, can weaken plants. A more serious pathogen, *Verticillium dahliae* Kleb., a common cause of wilt in mint-family plants (Fuentes-Granados, 1993), went unreported on *Agastache* until recently (Block et al., 1989). There is at least one strain of *Verticillium* that can produce lethal wilting in Korean mint (Block et al., 1989). One beekeeper in Iowa lost all his seedlings of Korean mint to this disease in 1986. We know this because the original strain of the pathogen was isolated from seedlings from his planting. Fortunately, *Verticillium* is significantly less able to infest anise hyssop than Korean mint (Fuentes-Granados, 1993). It is possible that the losses initially ascribed to nematodes in Oklahoma may have been due to *Verticillium* or to some other soil-borne pathogen.

Unattractiveness to Honey Bees

Although most respondents indicated that anise hyssop was attractive to honey bees, this was not universally so. At the Plant Introduction Station, the genus has always been exceptionally attractive to honey bees. Generally this has also been so at Michigan State University as well; but not always. When it is not attractive to honey bees, it is often attractive to bumble bees. Attractiveness of *Agastache* to bumble bees has also been reported in the literature. Those who read May's column might remember that Vansell (1933) reported a strong honey flow from *A. urticifolia* growing wild in California during 1931. The following year, it was attractive to mainly bumble bees, carpenter bees, butterflies, and hummingbirds. In addition, anise hyssop seed distributed from Pellett Gardens did not always produce plants attractive to honey bees. This was often associated with plantings in eastern states (M. Pellett, 1965). Although the Pelletts made little mention of its attractiveness to bumble bees under these circumstances, one of their collaborators from England did (Pellett, 1946). To us, this is one of the more baffling aspects associated with the genus because it is so inconsistent. Let us speculate on possible reasons for this perplexing phenomenon. Our list of hypotheses includes the following:

1. Lack of honey bees in the area
2. Bumble bees might mark the flowers with chemicals repellent to honey bees.
3. Bumble bee populations were extremely large.
4. The nectar level in the corolla tubes may not always be sufficiently high for profitable honey bee foraging.

5. A combination of these factors

We tend to reject the first possibility because in most cases the unattractive planting was in close association with one or more hives of bees.

We have included the possibility of bumble bees marking the flowers with a honey bee repellent primarily because it explains the observations so well. There is some evidence that bumble bees do mark flowers (Cameron, 1981), but this behavior seems to function primarily to allow the bumble bee to return to productive flowers. Without further evidence, we also reject this hypothesis.

With the advent of *Varroa* and tracheal mites there are probably local declines in honey bee populations. It is possible that these declines have increased nectar resources for other bees, allowing them to increase in numbers. During the summer of 1993, the anise hyssop plantings at Michigan State University were at times covered with bumble bees in far greater numbers than we had ever seen before. It was truly spectacular! Sometimes there were more than two bumble bees per plant in an approximately 2900 plant plot. The same planting that buzzed with bumble bees had few honey bees even though there were three or four honey bee hives within 100 yards of the planting. Although increasing bumble bee populations may be a local factor, we think it is not a universal explanation because, as pointed out above, the same phenomenon was reported in the literature for many years (Vansell, 1933 and Pellett, 1946).

In *Agastache*, the petals are united into the corolla tube that surrounds the stamens and pistil (see Fig. 3). Beekeepers often refer to this as the honey or nectar tube because of the nectar held in the bottom portion of this tube. We believe that the length of this tube is important in explaining the simultaneous unattractiveness to honey bees and attractiveness to bumble bees. Our belief is based more on anecdotal evidence than on hard scientific data, but it could explain many of the observations. During 1989 and 1990, work was underway at Michigan State University to select *Agastache* for characteristics that might improve its performance as a bee forage. The characteristics used to guide these selections were the production of many stems from a single rootstock and nectar production. The logic for examining stem number was twofold. First, the more a plant utilizes its available space (with stems), the more likely it will be competitive with weeds. Second, since each stem is terminated with flowers, an increased number of stems should lead to a higher density of flowers. Selections were made through two flowering seasons and the resulting plants were set out into side-by-side rows. During 1991, the plants in the row that resulted from selection for many stems were attracting honey bees,

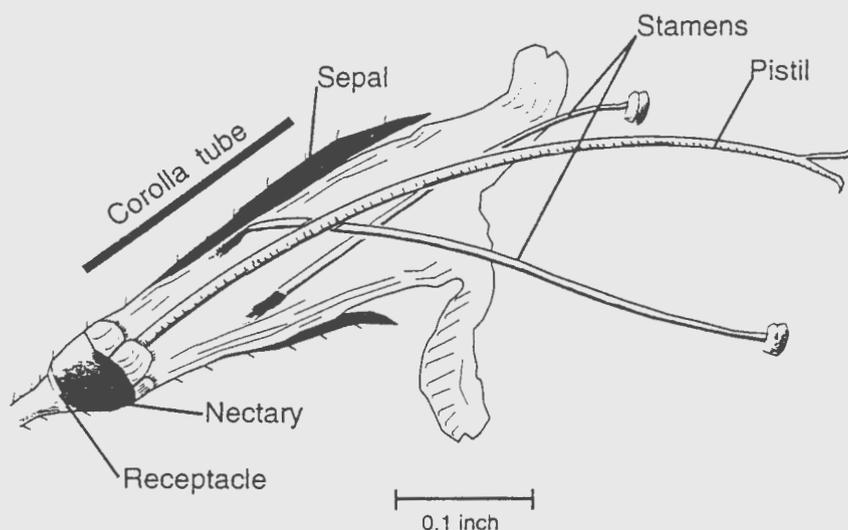


Figure 3 - Diagram of anise hyssop flower showing pertinent structures associated with nectar storage.

while those that had been selected for nectar production were attracting mostly bumble bees. This result was not anticipated and if it hadn't been so obvious, it would not have been noticed. Others brought to the patch without knowing why, also noticed it, indicating that the phenomenon was real. It was clear that both sets of plants had nectar to offer or both rows would have been devoid of both species of bees. Perhaps the plants attracting bumble bees held their nectar beyond the reach of the honey bees' tongues. The corolla tubes from plants selected for nectar production apparently were longer than those from plants selected for multiple stems, but unfortunately no formal data were collected. The technician associated with the project was also a professional photographer and attempted to capture the differences on film (see Fig. 4). It is known that there is sometimes a positive relationship between nectar production and the size of the nectar storage space. It might therefore be possible to breed plants that produce much nectar by selecting for size of nectar storage space. This is an appealing idea to those interested in breeding for nectar production because measuring nectar storage space is less tedious than directly analyzing for the quantity of nectar. Teuber and Barnes (1979) found that selecting for receptacle diameter (highly correlated with corolla tube diameter, see Fig. 3) was effective for improving nectar production in alfalfa. Because nectar storage space in many plant species is a function of both corolla tube diameter and length (see Fig. 4), selecting for nectar production might increase either or both dimensions. In retrospect, we believe that selecting for nectar production directly also selected for long corolla tubes that placed the nectar out of reach of honey bees.

There is a long history of apicultural literature dealing with the effect of corolla tube length on attractiveness to honey bees; much of it centers on red clover. Pellett (1937 and 1947), for example, described encouraging test results from a red clover variety (Zofka clover) with short corolla tubes. More recently, Jablonski (1975) described similar results with another red clover he bred for short corolla tubes. The phenomenon is not limited to clovers, however. A number of mint family plants (to which *Agastache* belongs) are thought to be unattractive to honey bees because of their long corolla tubes. Dafni et al. (1988), for example, studied the effect of several floral characters on attractiveness in nine species of mint family plants. In that study, species with long corolla tubes rarely attracted honey bees. As a result of the experience at Michigan State University with selecting for nectar production directly, we believe that future attempts at improving the nectar potential of *Agastache* should not stress assessment of total nectar pro-

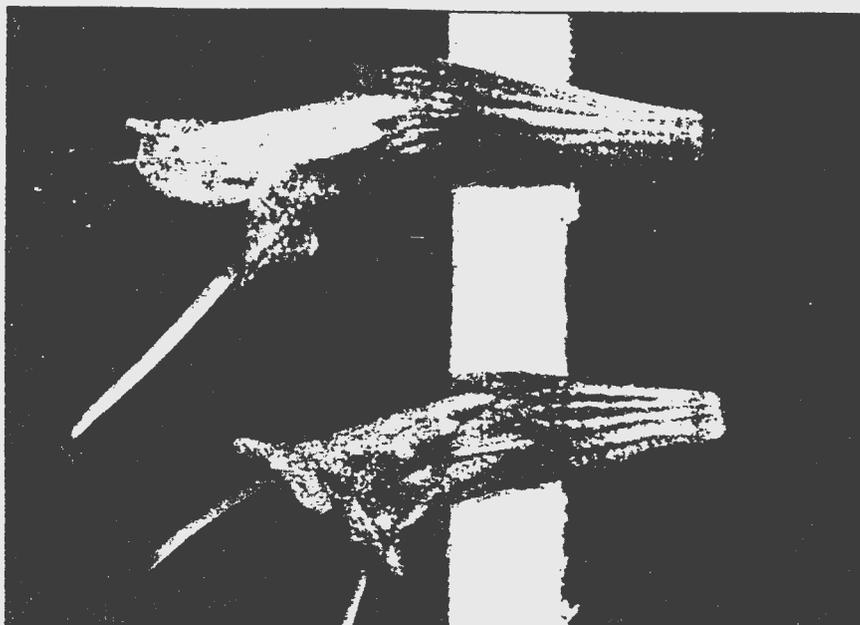


Figure 4 - Anise hyssop flowers taken from plants selected for nectar production (top) and production of many stems (bottom).

duction. We are currently considering two procedures. The first simply surveys attractiveness to honey bees to provide the guidance for selecting productive plants (Widrechner, 1992). In general, honey bees forage upon the most productive plants as long as nectar is made accessible (see Widrechner and Senechal, 1992 for a more complete discussion of this topic). The second alternative would be to use the difference between the nectar content of covered and uncovered flowers (similar to Wroblewska et al., 1993) to measure the nectar that bees are actually capable of harvesting.

Additional anecdotal evidence for our corolla tube length hypothesis is that, several years ago, some of Michigan State University's best *Agastache* honey bee forage was sent to Pennsylvania where it attracted only bumble bees. Although no honey bee censuses were made, there is no reason to suspect that honey bees did not occur in the area. The plants in Pennsylvania were placed in exceptionally fertile sandy loam garden soil. We speculate that, under these conditions, the flowers were larger than usual and, therefore, that the "honey tube" was also longer than usual, placing the nectar out of reach of the honey bees.

While we believe that long "honey tubes" are an important cause of *Agastache*'s reported unattractiveness to honey bees, we judge that this hypothesis is not the entire story. From those returns that indicate attractiveness to bumble bees, this attractiveness is not always consistent throughout the season. Sometimes the bumble bees were attracted early in the blooming period and were then replaced by honey bees. In other instances, the bumble bees displaced the honey bees. We speculate that not only is the phenom-

enon of competitive foraging between two species being observed, but that this is interacting with one or more other variables. Schaffer et al. (1979), based on their observations of competitive foraging patterns of bumble bees, honey bees and carpenter bees, argue fairly convincingly that bumble bees can survive as a colony on food resources of lesser quality than are needed by honey bees, because bumble bees rear much less brood than do honey bees and they do not engage in hive thermoregulation. They also do not overwinter as a large group that needs to be fed and warmed, but instead "hibernate" in protected spots as a few mated queens. Schaffer et al. (1979) also found that honey bees foraged slightly earlier in the day than did bumble bees. Given these findings, it seems possible that both types of bees might forage together early in the day and, as the nectar resources are reduced to levels beyond the reach of the honey bees' tongues, only the bumble bees would continue foraging. This situation would be exacerbated if the population of bumble bees increased because of reduced competition by honey bees as a result of the two introduced parasitic mites. It would also be particularly pronounced in small patches where nectar pools would be reduced very quickly to levels out of reach of the honey bees' tongues.

We hypothesize that the inconsistent seasonal foraging pattern results from an interaction with other bee forage in the area. Honey bees will generally forage where they secure the most return per unit of expenditure and so they may be drawn away from anise hyssop as more lucrative forage becomes available elsewhere. Alternatively, as another pasture becomes less lucrative, they may begin to visit anise hyssop. These are only hypotheses with

no substantiating data. During 1994, if a similar foraging pattern is found at Michigan State University as occurred in 1993, the diurnal and seasonal foraging patterns of both honey bees and bumble bees will be studied. It will be particularly interesting to see if there is an early period in the day when honey bees forage, followed by a period when only bumble bees forage. We would also be interested in hearing more from our readers about this phenomenon. The change-over period might be quite early in the day. In the Schaffer et al. (1979) study, it occurred around 6:00 AM daylight-saving time.

Bumble bees are not the only organisms that compete with honey bees for nectar on *Agastache*. The Michigan State University plots absolutely flutter with moths in the evening. This is not just a local phenomenon because one of our contacts from Iowa has reported it also. How much nectar do these moths "steal" from the bees? Although we do not have very much data on the topic, we judge that they steal very little. At Michigan State University, this plethora of nocturnal visitors was first noticed during a diversionary planting study (Ayers et al., 1991). One afternoon flowers were covered with a fine mesh. The next morning before daybreak, both covered and uncovered flowers were sampled for nectar content. It was reasoned that the difference between the two sample types (covered and uncovered) would represent what was taken by the moths. Data for these samples are presented in Table 1 under the heading, "Samples harvested at daybreak." As a comparison, data collected in a similar manner from mid-afternoon samples are also presented.

Table 1. Mg carbohydrate/flower for samples harvested at daybreak and mid afternoon*

Samples harvested at daybreak

Sample Date	Carbohydrate Per Flower	
	Covered	Open
7/10/86	0.049	0.024
7/17/86	0.066	0.061
Ave.	0.057	0.043

Samples harvested mid afternoon

Sample Date	Carbohydrate Per Flower	
	Covered	Open
7/3/86	0.199	0.025
7/18/86	0.297	0.036
Ave.	0.248	0.030

*Sample data are means from five samples of 20 flowers each

These data suggest that the plants began the evening with a residual nectar carbohydrate value of approximately 0.03 mg/flower, representing the amount not harvested by bees and other insects during the day. During the evening, a small amount of carbohydrate is secreted, and with no insect withdrawals, the standing crop is increased to approximately 0.057 mg/flower. Of this, the moths may harvest about 0.014 mg (0.057-0.043). Day-flying insects (largely bees) consume approximately 0.218 mg/flower (0.248-0.030), or approximately 15 times more than the nocturnal insects. Most of the nectar is secreted during daylight hours. This is a good strategy for *Agastache* if it is not pollinated by the moths. Why, after all, should the flowers pay for services not rendered? Apparently, the moths salvage only the residual nectar left by the bees.

Competition From Other Beekeepers

One of our contacts with quite a large planting reported that other beekeepers had moved hives near his planting. Needless to say, he viewed this as a form of thievery. Even though some states have laws to help prevent this, we suspect that most do not. Where no appropriate laws exist, we see no acceptable solution to the problem except through personal cooperation. We suggest the best way to avoid this problem is to be secretive about your bee forage planting activities. Perhaps many beekeepers are already following this strategy and this may be one reason why more replies were not received. It was one factor that led to our decision not to include the names of contributors in this article.

In conclusion, there may not be one overriding factor that has kept anise hyssop from serving as an exceptional bee forage. We have identified seven potentially troublesome areas. For those who would like to make an *Agastache* planting of their own, we will provide a set of recommendations in the September column to help avoid some of these problems.

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