Agastache scrophulariifolia: Essential Oils and Honeybees

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EXECUTIVE SUMMARY

Agastache scrophulariifolia, better known as the Purple Giant Hyssop, has an incredible market opportunity with its broad scope of commercial uses such as essential oil production, naturally flavored minty honey, and a staple in the cut flower market. With little research into the growth cycle, pest and disease resistance, and optimal growing conditions, much of the proposed requirements are acquired from existing practices with members of the same genus. Given *A. scorphulariifolia*'s extensive and precise taxonomic history, accurate inferences may be made with existing genus data to conclude correct growing techniques. A complete product information guide is created for future research and growing purposes, utilizing current research with educated inferences from the genus.

I. INTRODUCTION

A. Study Species.

Agastache scrophulariifolia belongs to the *Lamiaceae* family, better known as the mint family, and the *Agastache* Genus includes another 21 species, almost all of which are exclusive to North America. In the wild, *A. scrophulariifolia* provides an abundant nectar source for pollinators and has been observed to attract 14 different species of Hymenoptera and Lepidoptera. The flower is most visited by *the halictid bee (Agapostemon virescens*), leaf-cutter bee (*Megachile mendica)*, and the *Megachile texana* species during a study in Cape May, New Jersey (Sheahan 2012). The flowers of A. *scrophulariifolia* have also been observed to attract goldfinches and hummingbirds.

The common name for *Agastache scrophulariifolia* is most commonly "purple giant hyssop" but has also been historically called "prairie hyssop." Growing unusually tall for a

plant in the mint family at up to 1.8 meters tall, their upper branches showing a slight purple color, *A. scrophulariifolia* can be distinguished by their diamond-shaped stems, aromatic foliage, and vigorous stolons. The flowers of the *A. scrophulariifolia* are late-blooming and are fragrant, much like the foliage.

Inflorescences may range from a 2.5-15cm terminal, continuous, interrupted flower spike, or raceme while being very densely branched. Usually, *A. scrophulariifolia* will develop several points; the tops of the points develop into a flower, and two lateral branches under the flower form a node. This set node gives the inflorescence a symmetrical appearance. These clusters of flowers then continue to persist throughout the winter (Sheahan 2012).

The flowers are 0.6cm long with 15-nerved tubes ranging from lavender to pale pink. The upper lip of the flower has two lobes and projects forwards: and the lower lip curves downwards with three lobes. The individual lobes are 3-nerved. The flowers contain four stamens that extend beyond the flower. Two of those four stamens curve downwards while the other two stretch upwards. The pollen sacs are nearly parallel to each other. However, not all flowers on *A. scrophulariifolia* open simultaneously (Figure 1.).

The nutlets that *A. scrophulariifolia* produces are 1.5-2mm, dark brown, rounded, and minutely hairy at the squared-off tip. The stalked leaves of *A. scrophulariifolia* are positioned opposite on either side of the stem. The leaves are sharp-pointed, 10cm long, and 5cm wide, with a cordate, somewhat rounded base. The leaf margins are coarsely toothed, and short hairs cover the stems of the leaves. The undersides of the leaves are green and smooth but can sometimes appear shaggy. Finally, when the leaves are crushed, they emit an anise-like odor (Sheahan 2012).

B. Taxonomic Classification/History and Geographic Distribution in the Wild

While the genus *Agastache* belongs to the mint family, it was commonly referred to as the Lamiaceae or Labiatae family in Latin. The latter naming was lost in favor due to the Botanical Congress passing recommendations that all plant family names are to end in -aceae. Over time

the *Agastache* genus was given other names in its taxonomic history, such as *Lophanthis* and *Hyssopus*; this becomes confusing now as *Hyssopus* is currently an already recognized genus name. To make matters even more confusing, plants in the *Hyssopus* genus are commonly known as hyssops, such as the garden hyssop (*Hyssopus officinalis L.).* Many members of the *Agastache* species are often referred to as giant hyssops, hyssops, and *Hyssopus*; however, this is not always the case. The "giant" portion of the naming is often dropped for the *Agastache* genus; however, many specific *Agastache* species are referred to as giant hyssops (Ayers and Widrlechner 1994).

In 1948, the Agastache genus was separated into *Brittonastrum* and *Chiastandra*. The *Chiastandra* genus was promptly renamed *Agastache* as per the International Code of Botanical Nomenclature. The position of stamens classified the two sections of the genus; *Brittonastrum* has stamen pairs parallel to the flowers, while *Agastache* has lower stamens ascending to the upper lip of the corolla and upper stamens that are thrust downwards. At this time, there were eight species belonging to *Agastache* and 14 species labeled *Brittonastrum* (Lint and Epling 1948).

The *Agastache* genus is mainly identified by their upright growth habit with oval to triangular leaves oppositely arranged. Between the two sections of the genus, *Brittonastrum* contains leaf laminas that vary from 2 to 6 cm long (Sanders 1987). Meanwhile, the later section, *Agastache*, has a range of leaf laminar sizes from 1 to 15 cm long. Stems in the *Agastache* genus display as either simple or branched; under greenhouse conditions, the amount of branched versus simple is highly variable between both populations of *Agastache* and *Brittonastrum* (Vogelmann 1984). Stems of the *Agastache* genus are also squarish while containing a creeping root system that many others in the mint family share. However, *Agastache* differs from their related genera in that the *Agastache* root systems do not display the invasiveness mints are known for (Hevelingen 1994).

Flowers of the *Agastache* genus have been described as immobile or pedunculated verticils with either whitish or colored calyces and rose, violet, or white corollas (Lint and Epling 1948). The inflorescences of the *Agastache* section have a spike-like appearance with very compact verticillasters; rarely will they be moniliform. In opposition, the *Brittonastrum* section contains inflorescences very similar to *Agastache*, containing spike-like formations, but differ in that they may be continuous to brushlike. Their inflorescences may also be discontinuous and moniliform to loosely ramified, with their cymose clusters more separated close to the bottom while being more compact towards the meristem (Sanders 1979). *Agastache* inflorescences contain a multitude of tiny blossoms that open over a prolonged period. Much like the branching, the bloom duration is often highly varied per species (Widrlechner 1992).

Taxonomic studies of *Agastache* have been conducted more recently and have respectfully agreed with Lint and Epling in the sectioning of the genus. However, three species of *Agastache* listed by Lint and Epling, *A. parvifolia, occidentalis,* and *urticifolia*, so closely resemble one another that they could be combined into one highly polymorphic species with the three species now being understood as subspecies (Vogelmann 1984). Questioning the taxa within the genus, Vogel and Gastony conducted a biosystematic study by employing starch gel electrophoresis of isozymes to assess genetic relationships between the species (Vogelmann and Gastony 1987). This electrophoretic data led the *Agastache* genus into further sectioning, with there now four main sections of the *Agastache* genus. The first group consists of *A. nepetoids*; the second group, *A. scrophulariifolia* and *foeniculum;* the third group, four western species; and the final group, *A. Rugosa* (Vogelmann and Gastony 1987) (Figure 5.).

Almost all of the species belonging to *Agastache* are located in North America, with the exception of *A. rugosa,* which is originally native to parts of Eastern Asia. Native *A. scrophulariifolia* is primarily found throughout the United States into Northern Ontario (Tucker 2009). Due to habitat loss, predation, invasive species, and climate change, *A. scrophulariifolia*

is considered endangered in Connecticut and Massachusetts. They are deemed threatened in Maryland and Vermont, while they are listed as a particular concern in Kentucky and Tennessee (USDA 2018). While in their native habitats, *A. scrophulariifolia* tends to thrive in riparian habitats, disturbed areas, and meadows. *A. Scrophulariifolia* has the most excellent chance for success when competition between other native plants is reduced.

Since *A. scrophulariifolia* is a member of the mint family, it grows best in moist or wet conditions. It has also been found in rich woodland sites with dappled shade, woodland borders, meadows, thickets, upper floodplains, and upland woods. As stated above, it prefers disturbed soil but, more specifically, sandier soils with less competition. *A. scrophulariifolia* will not persist under hot and dry conditions like USDA zone 9 or higher (Sheahan 2012).

II. CROP SPECIES

A. History and Potential Uses.

In the wild, purple giant hyssop is an abundant source of nectar for nearby pollinators, making it ideal for pollinator restoration efforts. (Sheahan 2012) *A. Scrophulariifolia* has also been sought to improve yields in commercial honey production, especially since Pammel and King (1930) mentioned *A. scrophulariifolia* as being especially attractive to honeybees.

During a trip to Canada in 1925, Pellett (1926) describes *A. scrophulariifolia* as "...a very important source of surplus honey for the beekeepers of western Canada, being common in the bush regions and on the margins of prairies from Winnipeg to Edmonton." In this same article, he reported beekeepers near Red River, Manitoba harvesting large quantities of honey from the species and that 40 percent of the honey harvested near Edmonton came from *A. scrophulariifolia*. A sample of the honey was sent to him from the Edmonton area. In his words, he described the honey as "...of especially fine quality, with a peculiar minty flavor. The honey

was thick, with heavy body and light color, a product that would command attention in any market" (Pellet 1926).

Later in 1982, Mayer et al. published a paper that suggested that, in the drier areas east of the cascades of Washington, *A. scrophulariifolia* would "yield a surplus of 45 to 56 kgs of honey per colony with 25 colonies per acre." This roughly translates into around 1133 to 1458 kgs of honey per acre (Mayer et al. 1982). There were concerns that this claim was unreasonable since alfalfa was being grown in areas of *A. Agastache* planting, which is usually cut early since they are grown for seeds, then being cut too early for bees to use it. This was worrisome as this could contribute significantly towards an incorrect apparent production of anise hyssop fields. Personal communications with the authors of the Meyers paper revealed that there was no alfalfa planting near the *A. Agastache* test planting, which confirmed their findings (Ayers and Widrlechner 1994).

While useful for its bee foraging properties, *A. scrophulariifolia* is also a popular ornamental plant. *A. scrophulariifolia* is used for its relatively large height as a background against fencing (Sheahan 2012). Their fragrant foliage and attractiveness to butterflies and native bees make *A. scrophulariifolia* a prime candidate for backyard gardening. For home gardening, there are six readily available cultivars to choose from, including "Blue Fortune," "Premium Blue," "Liquorice Blue," "Carmine Red," "Premium Blush," and "White Liquorice." These cultivars are primarily distributed through mail-order nurseries or distribution agencies to be readily available to the consumer (Figure 4.).

Since *A. scrophulariifolia* is a member of the mint family, it contains many essential oils that provide aromatic and medicinal services. Under Middle Ural conditions, the essential oils produced by *A. scrophulariifolia* had the highest concentration of refined essential oils, amounting to 2.4% (Myadelets et al. 2013). While this may seem small, the second-highest producer of essential oils in the genus was *A. mexicana,* with a 1.2% essential oil yield (Myadelets et al. 2013) (Figure 2.).

Oil species inherent in *A. scrophulariifolia* are characterized by prevailing in menthone (34.7%), isomenthone (15.8%), pulegone (8.8%), methyl chavicol (8.1%), methyl eugenol (1.7%), pi peritone (1.5%), and spathulenol (1.1%). However, under the conditions of the southern coast of Crimea, the prevailing oil characteristics change drastically with methyl chavicol (85.6%), 1,8-cineole (4%), limonene (4.1%), linalool (1.6%), and linalyl acetate (0.6%) (Myadelets et al. 2013) (Figure 3.).

Menthone, mainly prevalent in areas not on the coast of Crimea, is a monoterpene highly associated with minty flavors. (Hirsch 2015) Menthone is used in flavorings, perfumes, and cosmetics for its aromatic and minty odor. Methyl chavicol, which is highly present in the Crimean variety, is commonly known as estragole. Estragole is most commonly used to prepare fragrances rather than the aromatic portion. However, it has more recently been suspected to be carcinogenic and genotoxic by the EU Committee on Herbal Medicinal Products. (HMPC 2005)

III. PRODUCTION INFORMATION

A. Anticipated Cultural Requirements.

Agastache scrophulariifolia requires soil disturbance for a successful establishment, so regular clearings must be created and maintained through methods such as tree-thinning. Elimination of competing vegetation or delaying natural succession cycles of the planting area also allows for the greatest chances of successful establishment. (Sheahan 2012) Many populations of *A. scrophulariifolia* tend to be short-lived because they are easily outcompeted in the wild. Because of this, field plots may need to be re-established every 3-4 years for fuller growth. To encourage fuller and more vigorous growth, cut 5-15cm from the plant (Sheahan 2012).

A. scrophulariifolia requires a moderate amount of sunlight to persist in the wild. Vogelmann had observed plants in "young, sparse deciduous woodlands with lots of sunlight

filtering through the canopy," noting that *A. scrophulariifolia* has the ability to tolerate shade. In shaded environments, the ability to thrive would require regular disturbance events to prevent canopy closure (Corrigan 2002).

The vectors for seed dispersal have yet to be identified in *A. scrophulariifolia*. However, current theories argue that a type of aerial seed bank may enable seeds to escape biodegradation in the soil or predation by animals such as mice or deer (Corrigan 2002).

Little is known about pests and pathogens of *A. scrophulariifolia*; Wilson (1908) merely lists that the taxon is a host for the fungus *Peronospora lophanthii*; however, it is currently unknown whether the fungus is pathogenic to the taxon. The *Agastache* genus is predominantly affected by mildews and rust, but other information is relatively unknown.

For growing *A. scrophulariifolia* commercially, it would be recommended to plant in fields rather than in a controlled environment such as a greenhouse. Field planting is recommended for its ability to yield products for multiple market niches at once, such as using the cultivated crops for cut flower arrangements, harvesting seeds for future plantings, harvesting seeds for the market, and using the planting area as a pollinator space for nearby bee colonies. Pollination and direct sunlight will help *A. scrophulariifolia* thrive since their native ranges are within open fields and meadows (Sheahan 2012).

Growing *A. scrophulariifolia* for personal use is widely up to the consumer for the method of planting. Since *A. scrophulariifolia* is present in the mint family, its ability to thrive in most environments is strong, giving it a strong chance at survival given proper care and cultivation. Given that greenhouse conditions are below a USDA zone 9, *A. scrophulariifolia* should establish successfully year-round. If the consumer has space for field planting, it would be highly recommended since their native range is within open fields and meadows (Sheahan 2012).

B. Market Niche.

Any growers looking for a pollinator plant that will supply a large amount of nectar to their bee foraging farms are in luck, as this plant fulfills those needs. Not only will *A. scrophulariifolia* provide large quantities of nectar for honeybees, but it will also give the harvested product a slightly minty flavor. This minty flavor in the honey collected from *A. scrophulariifolia* will provide a unique approach to the taste of honey and establish a solid consumer base who prefers minty tastes.

Before planting *A. scrophulariifolia* for commercial or personal use, cold stratification may be necessary depending on planting time. Planting in the fall is the easiest since no cold stratification is required, and the seeds should germinate when ambient temperatures reach around 20 degrees Celsius within 30-90 days. (Sheahan 2012). If planting in the spring or summer, cold stratification of the seeds will be required, keeping the seed at a constant 4.4 degrees Celsius for eight weeks.

Commercial field growing of *A. scrophulariifolia* has the potential to yield multiple products from one growing season, making it a potentially highly lucrative crop. A grower can produce cut flowers, seeds for next year's planting, seeds for distribution, and a pollinator site for nearby bee colonies from one growing season. Fields of *A. scrophulariifolia* enable honeybee production with the fabled minty honey as the desired product, pioneering a truly naturally flavored honey market. From the fields of *A. scrophulariifolia*, growers can also tap into the market of essential oils. Since *A. scrophulariifolia* has one of the highest essential oil concentrations in the genus, its scalability for oil production is high (Myadelets et a. 2013).

Outside the commercial, growing *A. scrophulariifolia* offers many advantages to the home garden. Home growers should expect to see honeybees and butterflies flocking to their gardens from the presence of this pollinator plant. If home growers reside in the areas where *A. scrophulariifolia* is natively found, eastern to central North America, then the addition of *A. scrophulariifolia* would increase the natural biodiversity of their natural communities.

Promoting *A. scrophulariifolia* in tangent to pollinator yards and gardens is a lucrative strategy since they are highly sought out throughout the nation. A survey reported that 96.5% of interviewees held a strongly positive view of flowering lawns (Smith et al., 2011).

IV. PRODUCT INFORMATION GUIDE (PIG) & CROP SCHEDULE

Production of *A. scrophulariifolia* is limited to seed production for nurseries and mail-order nurseries. There is currently no market for purchasing *A. scrophulariifolia* as cuttings or other alternatives besides seeds. *A. scrophulariifolia* seeds can be collected from the inflorescences when they turn dark brown from their usual purple coloring. Browning of the inflorescences will occur at the end of the growing season, which depending on which USDA zone they are located, occurs in mid to late fall (Sheahan 2012).

Currently, there are four significant cultivars of *A. scrophulariifolia* available for purchase as seeds. These cultivars, “Blue Fortune,” “Premium Blue,” “Liquorice Blue,” and “Premium Blush,” do not have current options for acquiring vegetative cuttings in a commercial environment. However, native seed and plant nurseries will occasionally sell *A. scrophulariifolia* as a potted plant instead of cuttings. These options are the closest to vegetative cuttings the market has to offer. The lack of options for vegetative cuttings illustrates the market potential *A. scrophulariifolia* offers, as one supplier could quickly profit from the lack of competition.

Growing *A. scrophulariifolia* from cuttings is the fastest way to acquire a well-established plant in the shortest amount of time. Taking late spring cuttings from the basal growth, which emerges in mid-March, allows for the fastest rooting rate in *A. scrophulariifolia* cuttings (Sheahan 2012). The rate of rooting can be further accelerated by fertilizing said cuttings. Transplanting cuttings into soils with a higher sand content is also preferred for a more rapid establishment.

Alternatively, from seeds, *A. scrophulariifolia* propagates rapidly in their natural settings. For more controlled environments, seeds require cold stratification and sunlight to reach germination (Sheahan 2012). Keeping the seed at 4.4°c for 30-90 days and raising the temperature to 20°c for germination will ensure the highest germination rate. Cold stratification is still required for seed propagation outdoors unless seeds are planted in the fall, as winter temperatures reflect their natural environment, and germination will occur in early spring.

For outdoor field production of *A. scrophulariifolia*, cuttings and divisions are the only suitable method to propagate and establish sterile, interspecific hybrids of A. scrophulariifolia populations that do not produce seeds when mature (Fuentes-Granados 1998). The growing season would start in early spring when *A. scrophulariifolia* natively starts its growing season. It would then persist into late fall, when seeds would usually be harvested for the next growing season. Following the ideas of Fuentes-Granados, producing seed-less sterile hybrids of *A. scrophulariifolia* would require cuttings, so instead of harvesting seeds, live culture cuttings would be harvested and transferred to a controlled environment.

Since *A. scrophulariifolia* struggles with competition, thorough weedings in outdoor field production are required. Using black plastic mulch and rigid beds reduces the need for manual weeding by up to 80 percent (Fuentes-Granados 1998). Mulching and ridging also increase fresh yields of *A. scrophulariifolia*, possibly due to an increase in soil temperature, a decrease in evapotranspiration, and a reduction in soil compaction (Fuentes-Granados 1998). Utilization of cover crops such as buckwheat (*Fagopyrum esculentum)*, which have allelopathic effects on weeds, has also been shown to decrease the need for manual weeding in *A. scrophulariifolia* plantings.

While there has not been an in-depth review of disease vulnerabilities of *A. scrophulariifolia*, *A. foeniculum*, which is in the same taxonomic group as *A.*

scrophulariifolia (Figure 5.), has a recorded susceptibility to *Verticillium dahlia* (verticillium wilt) (Fuentes-Granados 1998). It has also been noted that powdery mildew has been recorded on members of the *Agastache* genus in climates with dry, hot summers. Two-spotted beetles and green aphids tend to feed on foliage and congregate on flower spikes in more controlled environments.

Since there is an absent vegetative cutting market for A. scrophulariifolia, starting from seed is almost required for planting in a controlled environment. Seeds should be stored in a 4.4°c container for 30-90 days to induce cold stratification before sowing. Sow in a preferred growing plug tray, preferably a 108 for germination, and be sure to cover the seeds in 4 times their seed thickness in soil (Burpee 2021). Any germination mix should be sufficient; however, utilizing a sandy germination mix mimics *A. scorphulariifolia*'s native environment. While maintaining a temperature range of 20-22°c, germination should occur in 7-14 days, given that the soil is consistently moist.

After the 7-14 days required for germination, *A. scrophulariifolia* seedlings need full sun to continue to thrive. Positioning fluorescent growing lights 8-11 cm above the seedlings for 16 hours a day will perfectly replicate a full-sun environment. Incandescent lightbulbs will not work for growing *A. scrophulariifolia* because the bulbs emit too much radiant heat, which would interfere with growing (Burpee 2021). A dark period is required for *A. scrophulariifolia* to grow, so an 8-hour period of darkness is necessary for the growing period.

Fertilization is not a requirement in the earlier growth stages for *A. scorphulariifolia*. Starter solutions are preferred in the earlier growth stages, which is about half the strength of indoor houseplant food, and a fertilizer mix of 10-10-10 is the most desirable (Burpee 2021). Fertilizer is required when the seedlings reach 3-4 weeks old, utilizing the starter solution. When applying fertilizer, be mindful to keep the spread inches away from the plant's crown.

Transplanting is required when at least two pairs of true leaves have grown, preferably into an 8-11cm pot. Since *A. scrophulariifolia* is in the *Lamiaceae* family, their root systems require lots of space to develop a strong hold for the towering flowers. If these plants are going to be transplanted for field planting, they require a period to "harden." Young *A. scrophulariifolia* plants need a period to become adjusted to outdoor conditions, placing them outside, protected from the sun and wind, for seven days. This hardening period toughens the plant's cell structure and reduces plant transplant shock and scalding (Burpee 2021).

From germination, flowering should occur within 60-90 days, given optimal growing conditions (Burpee 2021). Utilizing *A. scrophulariifolia* for cut flowers has to be cut when the flowers are 2/3 open so that *A. scrophulariifolia* will be cut and shipped to the market within 30-60 days after germination. Depending on the distance the cuttings will be shipped in a cold container, they may have to be cut 1-2 weeks earlier than the prescribed 30-60 days. If plantings of *A. scrophulariifolia* are used for pollinator gardens or pollinator farms to utilize the naturally mint-flavored honey produced by bees that pollinate *A. scrophulariifolia*, then the harvest date would be in early fall to extract seeds for next year's planting. Growing *A. scrophulariifolia* for its essential oil properties would require a harvest time of 70-100 days after planting, giving optimal time for *A. scrophulariifolia* to reach maturity.

While *A. scrophulariifolia* has some of the highest concentrations of essential oils in the genus (Figure 3.), further selective breeding may increase future levels of essential oils. An increased essential oil concentration would lead to a higher volume of commercial oils produced with fewer plants and a more robust minty flavor in the honey pollinating bees produce. A higher concentration of oils would also allow the foliage and inflorescences to have a more pungent scent, making it more desirable in the cut flower market. Essential oils are a crucial aspect of the success of a flowering plant in a fragrance market, possibly creating an opportunity for a perfume based on the oils in *A. scrophulariifolia.*

Genetically selecting a variation of *A. scrophulariifolia* that is drought tolerant is a critical milestone in its commercial success. With increasingly severe aspects of climate change affecting our natural environments, in the future, there may be lesser amounts of water able to be used for commercial growing. In the *Lamiaceae* family, *A. scrophulariifolia* requires an adequate amount of water to thrive. Water use must be optimized for the potential growth of A. scrophulariifolia in the commercial market, given the increasingly dire status of climate change's effect on the global water supply.

The disease and pest vulnerability of *A. scrophulariifolia* are still relatively unknown, making large-scale investments a concern. IPM practices utilized for large-scale production of *A. foeniculum* may be effective at repelling possible pests and pathogens targeting *A. scrophulariifolia*. Future research into the vulnerability of *A. scrophulariifolia* would create a stronger incentive for widespread cultivation and investment in the potential markets. For a future commercial market in *A. scrophulariifolia*, disease and pest vulnerability are an area where more research is needed in order to thrive as an industry.

V. ACKNOWLEDGEMENTS

I would like to recognize the invaluable assistance of my lovely therapist in giving me the environment and tools to navigate my troubles and continue to thrive.

VI. FIGURES

Figure 1. Agastache Scrophulariifolia Inflorescence (Potterfield 2012)

Characteristics of the species under investigation belonging to genus *Agastache*

Kinds of seed	Origin	Yield of essential oil, %
Section *Agastache* Lint et Epling, subsection *Agastache* Clayton ex Gron.		
Agastache rugosa (Fisch. et Mey.) O. Kuntze	Germany	0.53
A. scrophulariifolia (Willd.) O. Kuntze	France	2.40
A. foeniculum (Pursch) O. Kuntze	Finland	0.83
Section *Agastache*, subsection *Oxyodontae* (Briq.) A. Budantz. comb. nov.		
A. urticifolia (Benth.) O. Kuntze	France	0.56
Section *Brittonastrum* (Briq.) Lint et Epling		
A. mexicana (Humbold, Bonpland et Kunth) Lint et Epling	Sweden	1.20

Figure 2. Agastache Genus Essential Oil Percentages, courtesy of Myadelets et al. 2013

Composition of essential oil inherent in genus *Agastache*

RI	Components	Component content, %				
		A. rugosa	*A. urtici-folia*	*A. foeni-culum*	*A. mexicana*	*A. scrophu-lariifolia*
979	Octen-3-ol	0.6	0.7	0.6	0.4	0.3
1100	Linalool	–	0.2	0.1	–	0.1
1154	Menthone	31.8	23.0	34.3	42.2	34.7
1165	Isomenthone	12.3	9.9	14.4	18.8	15.8
1199	Methyl chavicol	1.9	1.0	3.2	3.8	8.1
1219	*trans*-Carveol	–	0.2	0.2	0.2	0.1
1241	Pulegone	8.5	5.6	9.1	7.3	8.8
1245	Carvone	–	–	0.3	0.3	0.4
1255	Piperitone	1.7	0.6	1.2	–	1.5
1315	Car-3-ene-5-on	–	0.3	0.4	0.3	–
1359	Eugenol	–	0.3	–	–	–
1382	*trans*-Sabine propionate	–	0.3	0.2	0.2	2.7
1406	Methyl eugenol	4.8	3.6	3.1	1.1	1.7
1481	Methyl vanillin	–	–	0.2	–	–
1488	*B*-(*E*)-ionone	–	0.4	–	–	–
1509	δ-Amorphene	–	0.2	–	–	–
1580	Spathulenol	2.1	5.4	0.9	0.9	1.1
1586	Caryophyllene oxide	–	0.6	–	0.3	0.5
1641	Caryophyllene-4(12)8(13)-diene-5α-ol	0.6	1.5	0.3	0.3	0.4
1641	Caryophyllene-4(12),8(13)-diene-5β-ol	–	–	–	0.8	–
1658	α-Cadinol	0.4	1.8	–	–	0.2
1676	Caryophyllene 3,8(13)-diene-5β-ol, (3*Z*)-	–	0.8	0.9	–	0.3
1662	Caryophyllene 3,8(13)-diene-5α-ol, (3*Z*)-	1.4	–	–	–	0.9
1688	Eudesma-4(15),7-diene-1α-ol	–	0.3	–	–	–
1741	Oplopanon	–	0.7	–	0.2	–
1813	Cariolan-1,9β-diol	1.2	–	–	0.3	–
2000	*n*-Eucosane	1.5	–	–	–	0.7
2300	*n*-Tricosane	–	–	0.7	–	–
2600	*n*-Hexacosane	–	–	–	0.5	–

Note. Dash means that the content of the component does not exceed 0.05 %.

Figure 3. Essential Oil Compositions of the Agastache Genus, Courtesy of Myadelets et al. 2013

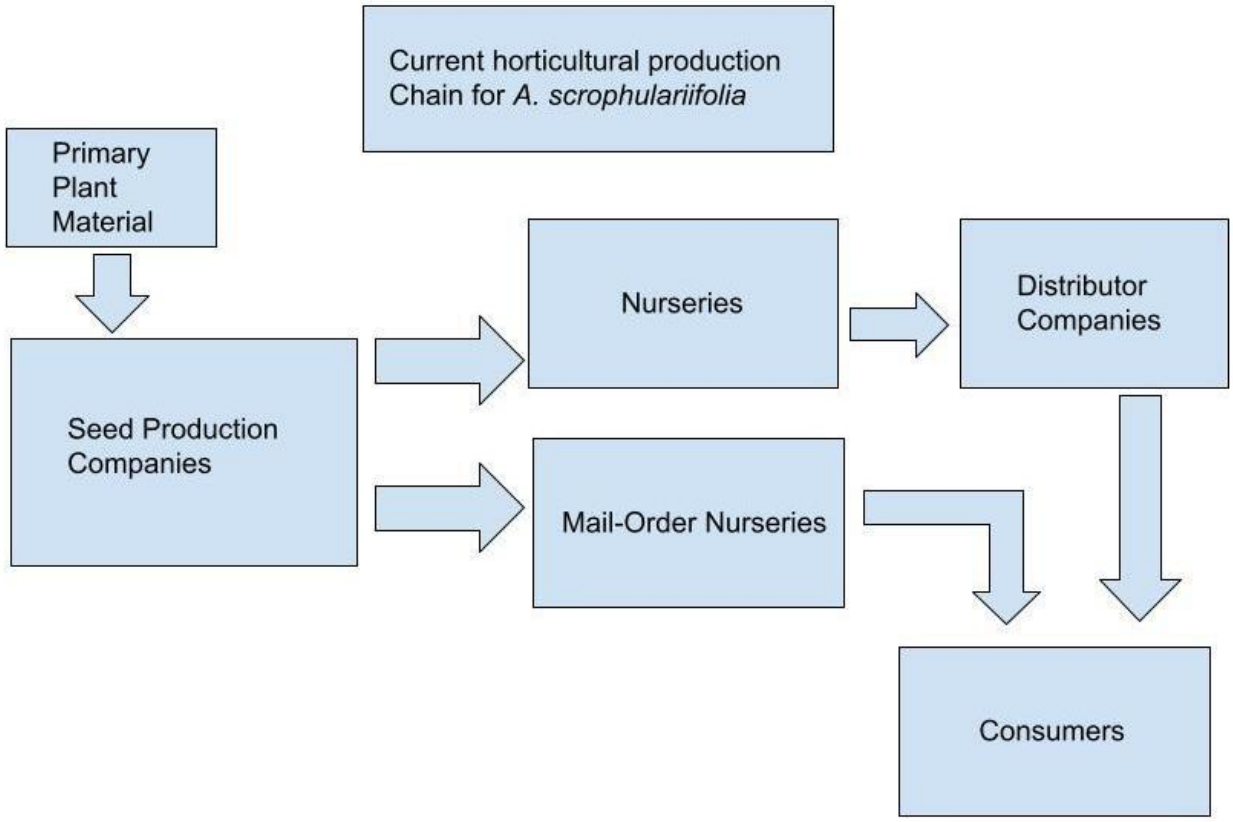

Figure 4. Current Horticultural Production Chain for A. scrophulariifolia

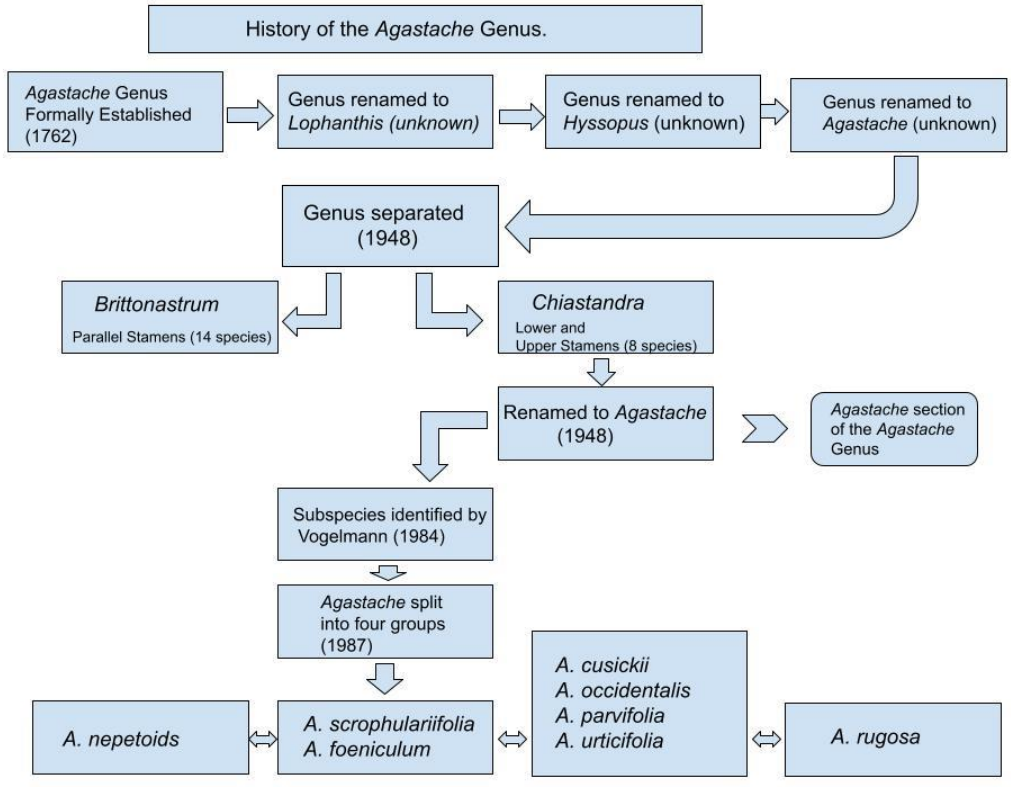

Figure 5. Illustrated History of the Agastache Genus

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