DISCUSSION

Sweet basil is cultivated in India on a commercial scale because the oil owes its importance to its extensive use in perfumery and confectionary industries. The present study is aimed to develop agrotechniques suited to Tamil Nadu climatic conditions for commercial cultivation. The results of the experiments conducted in this study are discussed under three chapters namely, Agro techniques, Pharmacognosy and Phytochemistry to have better knowledge on improving the quantity and quality of essential oil yield.

General conditions for crop growth

It has been observed that in Tamil Nadu conditions, the plant thrives best on moderately fertile but well drained loamy soils with good physical condition and good water holding capacity. Clayey and alkaline soils are not suitable for cultivation. Soil pH should be in the range of 4.3 to 8.2. The water logged lands must be avoided.

For commercial cultivation, sweet basil can be raised in early summer. For good vegetative growth, the temperature should be between 20 degree C and 38 degree C (Fig. A). The average annual rainfall around 104 mm (Fig. C). The crop is susceptible to frost and cold. It grows well in full sun. Though it flowers throughout the year, the peak flowering occurs when temperatures are relatively high 38 degree C and in long day conditions.

The seeds are found to be photoblastic and they require 8-12 hours of sunlight for germination (Fig. D). The crop does not grow well in shaded areas (Putievesky, 1983).

Studies on the yield and chemical composition of essential oils extracted from the leaves of sweet basil at different stages of harvest revealed that phenological stages of the crop have a positive correlation with temperature and humidity (Fig. A & B). Therefore,
FIGURE A : MONTHLY MEAN MAXIMUM TEMPERATURE (DEG C)

1999 – 2000

Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec
FIGURE B: MONTHLY MEAN RELATIVE HUMIDITY (%)

1999 – 2000
FIGURE C: MONTHLY TOTAL RAINFALL (MM)

1999 – 2000
FIGURE D: SUNSHINE HOURS
1999 - 2000
Trial – 1

Experiment on Seed development and Seed maturation

1. Field showing 60 days old plants

2. Tagging the inflorescence (70 days) for taking periodical observation

3. Field showing 90 days old plants

Trial – 2

4. Experiment on the effect of transplanting age of seedling and leaf removal frequencies on plant growth and yield

Trial - 3

5. Experiment on the influence of micronutrients on herbage and oil yield

6. Field applied with 0.2% Boron
harvesting of leaves should be done at the stage of maximum bloom to seed set and much before seed maturation.

A) Studies on Agro - techniques

1) Seed development and maturation studies

Studying the pattern of seed development and maturation enables us to understand the critical period of seed development so as to realize good sowing quality characteristics (Mathews, 1973).

The crop was raised in 4 square metres area to study the flowering pattern seed development and maturation. Sufficient number of flowers were tagged on 70th day after sowing. The flower samples were collected every 3 days interval till 113th day after sowing to fix the date of harvest of seeds with maximum germination. The results are discussed below.

a) Seed development
Three important stages of seed development have been identified:

i) initial period of development, ii) period of greater rate of accumulation of food reserves and iii) period of reduction of moisture content of seeds that indicates the maturation phase associated with faster dehydration (Karivaratharaju, 1974).

b) Seed maturation

If the seeds are allowed to be in the mother plants beyond the critical stage of maturity, it results in changes leading to loss of viability and vigour potential. Seed and seedling characters viz, dry weight of the seeds, germination percentage and seedling length were maximum with lower seed moisture content. The quantum of increase in the dry matter
production was maximum towards the attainment of physiological maturity. The increase in root and shoot length with higher accumulation of dry matter was due to the multiplication and elongation of cells.

c) Seed quality with regard to position of inflorescence

Seed quantity and seed quality in Ocimum basilicum L. were studied in connection with the growth and development of the plant including the branching pattern and position of the inflorescence (Figures-1,2 & 3 of Trial-1). Maximum quantity of seeds and highest germination were encountered in the secondary and tertiary branches, and not in the primary branches. Similar results were reported in Sweet basil by Putievesky (1983).

From the experimental studies, extending over a period of 102-108 days, it has been found that the seed yield determining parameters like dry weight of inflorescence and the number of floral whorls per inflorescence was found to be maximum. Seed germination was recorded maximum, when the moisture content of inflorescence and seeds was low. During this stage, the seed colour changed from pale yellow to black and the colour of the inflorescence changed from green to brown. It has been found that the seeds can be harvested between 110th day and 120th day and by then all physiological development of seed would be completed.

2) Effect of transplanting age of seedlings and frequencies of leaf removal on crop growth performance

The seedlings of 20,30, 40 days old were raised in 6 square meters field to know the effect of age of seedling on herbage and seed yield. In the same experiment the leaf removal was done once on the 60th, twice on the 60th and 80th, thrice on the 60th, 80th and 100th day. The plots without leaf removal served as control. The aim of the study is to know the effect of transplanting age of seedling and leaf removal frequencies on herbage and oil yield.
a) Transplanting age of seedlings on crop growth

The transplanting age of seedlings is an important factor in deciding the crop growth and yield parameters (Figure-4 of Trial-2). Delay in transplanting of seedlings after 30 days of sowing affect the growth of plants in terms of fresh weight and dry weight of leaves. The inflorescence and seed yield are also affected by delay in transplanting after 30 days.

b) Leaf removal frequencies on crop growth

Leaf removal more than thrice (ie.) on the 60th, 80th and 100th day reduces the plant height, production of inflorescence, seed weight, seed yield and seed quality parameters. However the herbage yield is high, when the leaves are removed three times.

In order to obtain high quality oil it is advisable to harvest only the flowering shoots. It is estimated that 3-4 tonnes of flowers /ha and 13-14 tonnes of herbage / ha in 3 to 4 harvests could be obtained. The plants should not be cut close to the ground level. The cut must be 15-20 cm above the soil. After the crop is harvested, it is advisable to allow the plant to wilt in the field for 4-5 hours to reduce the moisture. The crop should be cultivated separately with only one time leaf removal for maximum seed production. Collins (1978) reported similar type of results in Subterranean clover. The leaf removal studies conducted by different authors are discussed below.

In some species, fruit maturation and the initial synthesis of storage reserves and seed production are affected by leaf removal. In Piper arieanum, Marquies (1992) reported that, the leaf removal during the later stages of crop growth shows no detrimental effect. The effect is more during earlier defoliation. Karban and Myers (1989) recognized that fast and slow growing trees responded to leaf removal in different ways. Leaf removal from branches in trees and shrubs resulted in higher fruit abortion in those branches (Obeso, 1993)
FIGURE : 2 FIELD EXPERIMENT – II

Trial – 4

1. Experiment on the effect of different forms of fertilizers and their doses on herbage, seed and essential oil yield

2. Control plot (without any fertilizer)

3. Field applied with Farmyard manure @ 5 tonnes / ha + Wettable sulphur @ 25kg / ha + Ammonium Chloride @ 30 kg / ha

4. Field applied with Farmyard manure @ 5 tonnes / ha + Wettable sulphur @ 25 kg / ha + Ammonium Chloried @ 60 kg / ha

5. Field applied with Farmyard manure @ 5 tonnes / ha + Wettable sulphur @ 25 kg / ha + Calcium Ammonium Nitrate @ 30 kg / ha

6. Field applied with Farmyard manure @ 5 tonnes / ha + Wettable sulphur @ 25 kg / ha + Calcium Ammonium Nitrate @ 60 kg / ha

7. Field applied with Farmyard manure @ 5 tonnes / ha + Wettable sulphur @ 25 Kg / ha + Urea @ 30 kg / ha

8. Field applied with Farmyard manure @ 5 tonnes/ha + Wettable sulphur @ 25 kg / ha + Urea @ 60 kg / ha
3) Impact of Fertilizers

The crop was raised in 20 square meters area and three different forms of fertilizers viz., urea, calcium ammonium nitrate and ammonium chloride with 2 different doses (ie.) 30 kg/ha and 60 kg/ha, were applied to know the effect of ammonium and nitrate nitrogen on herbage and seed yield.

a) Importance of different forms of fertilizers on crop growth performance

Selection of suitable type of fertilizer and its doses are the most important parameters that influence the higher yield of herbage and essential oil yield. While selecting the type of fertilizers, soil condition should also be considered. Soil conditions such as acidity, including acid peatmuck soils (Haynes, 1986 b), low soil temperatures (Haynes, 1986 a) and poor aeration (Haynes, 1986 a; Wells and Turner, 1984) reduce the rate of nitrification.

b) Effect of ammoniacal and nitrate form of nitrogen on crop growth

There is much contradiction in literature on the relative effectiveness of nitrate and ammonium as a source of nitrogen for plants. Some plants grow well with nitrate nitrogen (Harda et al., 1968) and others with ammoniacal nitrogen (Townsend, 1967). The effects of source of Nitrogen vary with age of crop (Takahashi and Yoshida ,1956). The major inorganic forms of nitrogen absorbed by plants are nitrate (NO\(^-\)\(^3\))and ammonium (NH\(_4\)^+). Both forms of nitrogen are present naturally in the soil solution. NH\(_4\)^+ is formed by the decay of organic matter and nitrate is formed by nitrification .

c) Effect of ammoniacal nitrogen on crop growth

The results of this experiment reaveled that application of ammoniacal nitrogen decreases the plant height, leaf dry weight and also the essential oil content. This form of nitrogen alters the essential oil content of sweet basil. In sweet basil, the decrease in growth
under ammonium nutrition could be attributed to its toxic effect due to the accumulation of ammonium ions and abnormality in the organic acid metabolism (Harda et al., 1968). Ammonium nutrition also decreases the percentage of calcium and magnesium in the plants and reduce the leaf size, inflorescence height and seed weight.

d) Effect of nitrate nitrogen on crop growth

Plants with nitrate nutrition grow taller and have increased leaf area, leaf weight per plant than with ammonium nutrition. Plants without application of any type of fertilizer showed stunted growth with less number of inflorescence and poor herbage yield (Fig. 1 & 2 of Trial-4). Similarly plants applied with ammonium chloride did not show any significant results as far as the herbage, seed and essential oil yield are concerned (Fig. 3 & 4 of Trial-4). The present findings show that for sweet basil, application of ammonium as a source of nitrogen suits best during early stages of crop growth (i.e.) within 3 weeks after sowing (Fig. 5 & 6 of Trial-4). Application of nitrate is suitable during later stages i.e. 70th day after sowing. It increases plant height, quantity of seeds and quality essential oil yield (Fig. 7 & 8 of Trial – 4).

Similar type of studies were reported by different authors in different plants. Naftel (1931) found that maize, cotton and wheat absorbed more nitrogen from ammonium source at early stages (up to 28 days) and from nitrate source at later stages (after 35 days). Stahl and Shive (1933) found that oat plant took up ammoniacal nitrogen at early stages of crop growth. In Japanese mint, Singh and Singh (1978) found that ammonium nutrition reduced the plant height, number of branches and plant dry weight. However the essential oil of leaves was recorded high by nitrate nutrition on single plant basis.

4) Micronutrient Studies

For micro nutrient studies, sweet basil was raised in a 20 square meters area. The crop was applied with boron as borox (0.1, 0.2 & 0.3%) manganese as manganese sulphate (0.1, 0.2 & 0.3%), molybdenum as ammonium molybdate (0.03, 0.06 & 0.09%) and copper as
copper sulphate (0.05, 0.1 & 0.2%). The effect of these micro nutrients on crop growth and essential oil yield is discussed below.

a) Importance of micronutrients application on essential oil yield

The production of essential oil of high quality from the herbage depends upon the balanced use of fertilizers and micronutrients. The depletion of micronutrients from the soil affects the yield and quality of oil. The application of nutrients plays a significant role in improving the growth of plant and oil yield in sweet basil. Non-availability of micronutrients affects the oil content in plants. Absence of copper, manganese and iron reduces the yield of essential oil (Gupta and Shah, 1989). Micronutrients also influence the growth parameters, such as the height of the plant, branching pattern and the herbage yield (Fig. 5 & 6 of Trial-3). Among the different micronutrients applied, application of 0.2% boron as borax during flowering stage increased the inflorescence, herbage and essential oil yield.

b) Effect of boron on crop growth and yield

Plants to which boron was not provided developed visual symptoms of boron deficiency such as necrosis of leaf apex, stunted growth, small and thick leaves. Herbage yield, plant height and branching were reduced when boron was not applied. The oil recovery and oil percentage (linalool and methyl chavicol) got reduced due to the deficiency of micronutrients.

Similar type of studies were reported in mint (Mentha arvensis L. var. piperascens, Mal) by Abad Farooqui and Misra (1983); in Ocimum tenuiflorum L. by Dey and Choudhari (1980); in Ocimum gratissimum L. by (1986) and Pareek et al. (1984) in Cymbopogon sp.
5) Monthwise germination studies

Freshly harvested seeds of sweet basil was stored up to a period of 13 months. The germination percentage of the seed from stored seeds is recorded and analysed for each month.

a) Germination behaviour of seeds during storage

As the period of seed storage increases, the percentage of germination also increases (Figure-17). It reaches its peak (70%) on the 9th month (270 days) and thereafter decreases. There is a low percentage of germination of seeds initially, due to seed dormancy. For better germination, it is advisable to use 6-9 months old seeds.

b) Influence of temperature on germination of seeds

Basil is chiefly a summer crop and is suited to warm conditions. Seeds sown during the month of July (late summer) and harvested in October record the highest percentage of germination. In contrast, seeds sown during rainy season record very poor germination which reveal the photoblastic character of seed. Germination of basil seed was rapid and reached a high percentage especially at temperatures between 21°C and 30°C. Over 80% germination was achieved on or after the 4th day of sowing (Putievsky, 1983).

Similar behaviour of seeds of Clocimum (Ocimum gratissimum L.) showed low germination percentage (40%) immediately after harvest (without storage) which indicates the presence of initial partial dormancy. 1 month old seeds recorded sudden increase in germination (72%) and reached 96% on 3 months of storage. Thereafter the rate of germination got reduced to nil after 6 months of storage (Anon, 1983., Shylaraj and Thomas, 1992).
6) Dormancy of fresh seeds

Freshly harvested seeds of sweet basil are reported to have 3 months period of dormancy. Dormancy is generally due to

1) Immaturity of the embryo.
2) Impermeability of the seed coat to water / gases.
3) Prevention of embryo development due to mechanical causes such as lack of required temperature / light, presence of substances inhibiting germination, etc.,

The sensitivity of seeds to water tension i.e. their ability to germinate at lower water potential is determined in some cases by the presence of the mucilage cover (Harper and Beaton, 1966). Excess moisture can also prevent germination apparently due to diffusion. The seeds absorb water and immediately form thick mucilagenous coat which prevents the supply of oxygen needed for the germination of the seed.

The structure in the seed for impermeability is the palisade layer of seed coat. This consists of waxy hemicellulose or pectinaceous substances deposited over the testa (L.O. Copeland, 1988).

a) Seed mucilage

In sweet basil a sub-cuticular layer described as a mucilage structure is sometimes conspicuous (i.e.) it may become gelatinous or mucilagenous when wet. It consists of pectin in the outer part and hemicellulose in the inner part and becomes very hard and hydrophobic during the later stages of seed maturation. This prevents the entry of oxygen in to the seed. This mucilage consists of D-Glucose, D-Xylose, D-Rhamnose and D-Galacturonic acid (Tharanathan and Anjaneyalu, 1974).
Biochemical analysis of seeds in sacred basil (*Ocimum tenuiflorum* L.) offers some clues to the fall in germination percentage of seeds. The freshly harvested seeds recorded low germination due to incomplete seed filling and hollowness. The increase in insoluble carbohydrate might be ascribed to high mucilagenous substances present in seed coats. Other than carbohydrates, the endogenic substances like polyphenols and free amino acids have been related to seed germination (Dey and Choudhuri, 1982; Tsvotkov et al., 1975).

7) Improving germination of fresh seeds

Seeds of Sweet basil when soaked in water forms a mucilagenous coat. The presence of this mucilage prevents seed germination (Figure-15). Fresh seeds are also reported to have pronounced dormancy. Similar type of seed dormancy up to 8 months in freshly harvested seeds were reported in Safed musli (*Chlorophytum tuberosum*) by Devendrakumar shrivastava et al. (2000-2001).

For this purpose seeds were given various acid and alkali treatment. Acid treatment was not effective in improving the germination of sweet basil seeds. In alkali treatment seeds were soaked in 2% solutions of alkali viz., KOH, NaOH & CaOH for 6-12 hours. Except CaOH, other 2 alkali did not reduce the mucilage around the seed coat as well as improve the germination. So to improve the germination of freshly harvested seeds soaking in 2% CaOH for 12 hours is advised.

To break the dormancy of fresh seeds, soaking the seeds in potassium dihydrogen phosphate @ 100 ppm for 12-16 hours. However this method is not applicable for 6-9 months old seeds. Similar type of seed invigoration studies in some medicinal plants were carried out by Sheela verma et al. (2000) and Veena gupta (2000).
8) **Standardising leachate tests comparing fresh and six months old seeds**

Normally seeds undergo the process of deterioration where stored for more months. In order to know the rate of this deterioration process, some of the leachate tests were performed to compare the germination of fresh and old seeds.

In sweet basil the rate of deterioration was lower in old seeds compared to fresh seeds. Increased leaching of inorganic salts has been suggested as an index of viability and field emergence (Hibbard and Miller, 1928; Mathews and Bradnock, 1967). Electrical conductivity and pH of leachate from the seed is a good index of vigour (Grebe, 1967).

The increase in electrical conductivity from the leachate was considered due to degradation of cellular membrane and subsequent loss of control of permeability. Leaching of sugars appears to be regulated primarily by the rate of utilization of sugars during germination. It was found from the experimental results that 6 months old seeds of sweet basil has higher germination than fresh seeds.

**B) Pharmacognosy**

Lamiaceae includes several genera of economic uses. These genera can be distinguished with ease from other related plants both by the vegetative and floral characters. The large genus *Ocimum* comprises species that have evolved highly overlapping characters and much laborious to key out. The vegetative as well as floral characters of the species included under *Ocimum* cannot be easily utilized for identification of the plants. Even though all species of *Ocimum* are medicinally valuable, some of them are highly priced for their aromatic oil. *Ocimum basilicum* is economically important both for its leaves and seeds. Thus, the species has great market value and is in much demand. On account of its higher demand, other species of *Ocimum* are likely to be adulterated with *Ocimum basilicum*. So, pharmacognostic diagnosis of *Ocimum basilicum* is essential to prevent adulteration and substitution. Information available for botanical diagnosis of *Ocimum basilicum* is not only meagre, but also too elementary (Srivastava et al., 1974,
Gopalakrishnan et al., 1991, Vadukkoot and Prasannakumari, 1999). In the present study, anatomical features of mature plants are presented, which may offer easy guidelines for botanical identity of the species. The anatomical characters presented here are based upon observations made on materials from plants cultivated for the experimental purpose.

a) Leaf anatomy

The mature leaves have dorsiventral differentiation of the lamina into adaxial palisade and abaxial spongy mesophyll tissues. The leaf is amphistomatic and are diacytic. The midrib consists of a less prominent shallow abaxial part with a single collateral vascular bundle (Fig.4).

Young leaves and internodes bear abundant glandular trichomes which possess small stalk and spherical or peltate body; the glands occur on the surface or within shallow pits (Fig.8, 9&10). In addition to the glandular trichomes, there are also non-glandular, multicellular, unbranched pointed trichomes along the margins of the leaf (Fig.7).

b) Petiole

The petiole is semicircular in cross-sectional view with single arc-shaped vascular strand and parenchymatous ground tissue (Fig.5). Young internode is four-angled with four shallow furrows. The ground tissue of the stem is homogeneous and is of parenchymatous tissue with four segments of vascular tissues (Fig.6). The node is unilacunar with a single leaf trace (Fig.5.2).

c) Seed morphology

The seeds have characteristic cuticular pillar-like projections with mucilage filling the gaps between the cuticular pillars (Fig.12). The mucilage consists of polysaccharides (Tharanathan and Anjaneyalu, 1974). The role of copious quantum of mucilage in the physiology of the seed is only speculative. It may obviously protect the embryo within the seed from external adverse conditions; on wetting, the mucilage swells into a thick layer of white gelly-like substance; the mucilage may probably transmit the absorbed water to the developing embryo. These two presumptive roles of the seed coat mucilage seem to be
logical inference. The aforesaid anatomical characters will be sufficient to identify the stem, leaf and seeds of *Ocimum basilicum*. Other species of *Ocimum* may share one or two features of *Ocimum basilicum*. However, when all the features are combined will help to fix the species without any doubt.

d) Pollen grain morphology

It was observed that pollen grains were flattened and spheroidal with 6 furrows and 6 sided colpi (Fig.15). The polymorphological features of the 2 cultivars of *Ocimum basilicum* was compared by Zheldijazkov et al. (1996).

e) Comparision of 30, 60 and 90 days plants based on the gland development

Plants ageing 30, 60 and 90 days were studied separately for their oil yield. It was found that maximum yield of oil was from the plants aged 60 days. Microscopic examination of leaves collected from these three age groups revealed that the density of glandular trichomes was maximum in the plants of 60 days old; further, the glandular trichomes were observed to acquire full development with maximum contents of oil. In the leaves of 30 days plants, the density as well as maturity of the glandular trichomes donot attain the full complement. In the 90 days plants, the glands started dehiscing and liberating the contents. Therefore for obtaining highest yield of oil, the ideal age of plant seems to be 60 days.

C) Phytochemistry

Essential oils are a diverse group of natural products that are important sources of aromatic and flavouring chemicals in food, industrial and pharmaceutical products. The basil oil is found to be rich in Linalool (73 %)(Fig.18).
FIGURE 22: GC-MS OF 30 DAYS OLD LEAF SAMPLE OF SWEET BASIL

COMPOUND NAME: 1,8 CINEOLE (1.49%)
FIGURE 23 : GC-MS OF 60 DAYS OLD LEAF SAMPLE OF SWEET BASIL

COMPOUND NAME : 1,8 CINEOLE (8.91%)

BASE PEAK : 43.20 (741852)
FIGURE 24: GC-MS OF 90 DAYS OLD LEAF SAMPLE OF SWEET BASIL

COMPOUND NAME: 1,8 CINEOLE (9.67%)
FIGURE 25: GC-MS OF 30 DAYS OLD LEAF SAMPLE OF SWEET BASIL

COMPOUND NAME: LINALOOL (38.55%)
FIGURE 26: GC-MS OF 60 DAYS OLD LEAF SAMPLE OF SWEET BASIL

COMPOUND NAME: LINALOOL (56.99%)
FIGURE 27: GC-MS 90 DAYS OLD LEAF SAMPLE OF SWEET BASIL

COMPOUND NAME: LINALOOL (72.63%)
FIGURE 28 : GC-MS OF 30 DAYS OLD LEAF SAMPLE OF SWEET BASIL

COMPOUND NAME : ISOEUGENOL (22.91%)

BASE PEAK : 164.4 (152743)

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FIGURE 29: GC-MS OF 60 DAYS OLD LEAF SAMPLE OF SWEET BASIL

COMPOUND NAME: ISOEUGENOL (6.91%)

BASE PEAK: 164.35 (151886)
FIGURE 30: GC-MS OF 90 DAYS OLD LEAF SAMPLE OF SWEET BASIL

COMPOND NAME: ISOEUGENOL (3.68%)
The leaf samples of 30, 60 & 90 days old were collected for estimating the percentage of essential oil and its components, to know the best harvest time for maximum oil recovery. The crop was raised under Tamil Nadu agroclimatic conditions, found to contain 73% Linalool during 90 days of crop growth, while it was 39% on the 30th day (Fig. 25, 26 and 27). The percentage of isoeugenol was found to be 23% on the 30th day and it was 4% on the 90th day (Fig. 28, 29 and 30). The essential oil also contains another compound 1,8- cineole which was recorded 2% on the 30th day and it was 10% on the 90th day (Fig. 22, 23 and 24).

However, Maheswari and Singh (1989) & Lemberkovics et al. (1996) reported that in the crop (EC174527) raised under Delhi conditions, Linalool (40 - 60%) was found maximum during early crop growth stages and as the stage advanced it has decreased to (25-30%) and Sesquiterpines have increased. Hence the agro climatic variations have significant effect on essential oil components.

Herbage should not be exposed to sun for prolonged drying, as it adversely affects the quality of oil. Among the different distillation methods steam distillation is the best (Maheswari and Singh, 1989). It takes less time and gives better recovery of herbage oil. To have maximum oil recovery, harvesting the herbage from the 60th to 90th day after sowing is recommended.
SUMMARY

In the present study of sweet basil, some of the agro-techniques are standardised to give better knowledge on cultivation practices to the farmers.

The crop was sown in early summer. April-May is the best season for sowing sweet basil seeds. The soil selected for cultivation was well drained sandy loam/loamy soil with pH of 4.3-8.2. The day temperature of the area chosen for cultivation of the crop ranges between 29 degree C to 38 degree C. The average annual rainfall recorded is 104 mm. The seeds are photoblastic and requires 8-12 hours of sunlight for germination and subsequent growth.

Sweet basil is an upright plant growing to a height upto 1 meter with a few branches. Under field conditions 45 x 30 cm spacing is recommended for cultivation of this crop. The ideal age of transplanting the seedlings is 30 days. Pollination is through bumble bees and blister beetles. 60-70 % cross pollination was recorded in the field. Flowering starts from the 60th day after sowing and reaches its maximum on the 85th day. The seeds attain physiological maturity in about 102-108 days. Seeds harvested during this time show maximum germination.

The crop is commercially grown for its leaves. Leaf harvest is started from the 60th day onwards with 20 days interval upto the 100th day. For getting maximum herbage yield with high recovery of oil, leaves are harvested from the 60th day to the 90th day.

To have maximum yield, crop is applied with 5 tonnes of farmyard manure along with 25 kg wettable sulphur / ha at the time of last ploughing. Basal application of 30 kg / ha of nitrogen in the form of urea, 40 kg / ha phosphorous and 40 kg / ha muriate of potash was adopted. The balance of 30 kg / ha of nitrogen was applied equally in 2 splits. Top dressing of 15 kg / ha of nitrogen was applied in the form of calcium ammonium nitrate on 70th day after sowing nitrate for higher herbage, seed and essential oil yield.
Application of micronutrients (i.e.) boron (0.2 %) during 60-65 days of crop growth increased the inflorescence yield and essential oil yield.

Harvesting of seeds was done from the 110th day onwards. Freshly harvested seeds are dormant for 3 months. Germination of seeds reached 70 % on the 9th month of storage. To improve the germination of freshly harvested seeds, treatment with 2 % calcium hydroxide for 12 hours was done. This reduced the mucilage cover surrounding the seed coat and improving the germination. To break the dormancy, seeds were soaked in potassium dihydrogen phosphate @ 100 ppm for 12-16 hours.

Studies on the anatomy of the leaves revealed that there are two basic categories of trichome structures. 1) Non-glandular covering type trichomes which are multi-cellular, uniseriate and unbranched. They usually occur on the veins and margins of leaves. 2) Glandular trichomes. They are of two types: a) Multi-cellular with short stalk and spherical head. b) Multi – cellular with peltate head without stalk. These glandular trichomes occur on all the tender organs of the plant. The leaves of 30, 60 and 90 days old plants were studied for gland development and compared. The studies revealed that maximum occurrence of glandular trichomes were found on 60 days old leaves. The glands started dehiscing, releasing the oil bodies from the leaves collected on the 90th day.

The estimated herbage yield recorded was 20-22 tonnes/ha and the seed yield was 2-3 tonnes/ha. under Tamil Nadu conditions. The essential oil recovery from fresh leaves is 0.4-0.5 %. The colour of the oil is brown. Oil is pungent with camphor odour. The oil is rich in linalool (73 %) followed by 1,8 cineole, eugenol (4 %) and methyl eugenol (7 %). The development of oil components is maximum from 60th day onwards. Hence it is advised to harvest the leaves for oil extraction from the 60th day onwards.