

Organic cultivation of
Bacopa monnieri* and *Ocimum sanctum



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Ocimum sanctum

Ocimum sanctum is commonly known as Tulsi or Holy Basil, which is a species worshipped by the Hindus. *Ocimum sanctum* belongs to family Lamiaceae. Among different species of genus *Ocimum*, the species *sanctum* occupies wide range of habitats. Among Indian species, *Ocimum basilicum* and *Ocimum sanctum* have the widest distribution, which cover the entire Indian subcontinent.

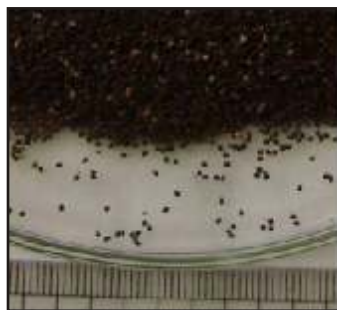
The economically important part of *Ocimum sanctum* is its herb (leaves and tender parts of the shoots). In ayurveda the *Ocimum sanctum* leaves, flowers and occasionally the whole plant is used medicinally in the treatment of heart and blood diseases, leucoderma, strangury, asthma, bronchitis, lumbago and purulent discharge of the ear. The leaf juice possesses diaphoretic, antiperiodic, stimulant and expectorant properties. It is used to treat infantile cough, cold, bronchitis, diarrhoea and dysentery and it is applied to the skin to treat ringworm and other skin diseases.

An infusion of the leaves is used as a stomachic for gastric disorders in childrens.

The oil extracted from the leaves is reported to possess antibacterial and insecticidal properties, and is effective as a mosquito repellent. The aromatic compounds found in the essential oils of *Ocimum sanctum* are mainly the mono-terpenes, sesquiterpenes and phenols, alcohols, esters, aldehydes, ketones and others.



Ocimum sanctum



Ocimum sanctum seeds

BOTANY

The genus *Ocimum* belongs to subfamily *Ocimoideae* of the family *Lamiaceae*. The plants of *Ocimum sanctum* are predominantly shrubs and herbs and are perennial in habit. The plants are usually much branched. Stems and twigs are usually quadrangular. Young twigs are greenish, purplish or brownish in colour. The leaves are simple, petiolate and ovate. They possess glandular hairs or stalked and sessile glands which secrete volatile oils and they exhibit racemose type of inflorescence. Flowers are hermophordite, zygomorphic and complete. Seeds are mostly brownish, globose or subglobose and are shining or non-mucilaginous.

VARIETIES

Central Institute of Medicinal and Aromatic Plants, Lucknow has released the varieties CIM-Ayu and CIM-Kanchan.

SOIL AND CLIMATE

Ocimum sanctum thrives well on a variety of soils and climatic conditions. Rich loam to poor laterite, alkaline to moderately acidic soils are well suited for cultivation of *Ocimum sanctum*. Well drained soils help in better vegetative growth. It flourishes under fair to high rainfall and humid conditions. Long days and high temperatures have been found to be favourable for plant growth and higher oil production. Tropical and subtropical climate is suited for its cultivation. Waterlogged conditions can cause root rot and result in stunted growth. So proper drainage should be provided.

NURSERY PREPARATION

The plantations can be raised by raising seedlings in the nursery. Raised seedbeds should be thoroughly prepared and well manured by addition of farmyard manure or vermicompost. The seeds should be sown in the nursery. About 20-30g seeds are enough to raise the seedlings for planting one hectare land. After sowing the seeds in the nursery, a mixture of FYM /Vermicompost and soil is thinly spread over the seeds and irrigated with a sprinkler hose. The seeds take about 8-12 days to germinate and seedlings are ready for transplanting in about 6 weeks time.



Raised beds for nursery



Ocimum planting material

SPACING

Spacing of 60 × 60 cm is found suitable for *Ocimum sanctum*.

TRANSPLANTING :-

The seedlings that are 5-6 cm long are ready for transplanting (i.e 4-5 weeks old seedlings).

IRRIGATION

The crop is irrigated immediately after planting. Seedlings are established well by the time of second irrigation. It is the right time to get the gaps filled and replace the weak plants so that uniform stand is achieved.

In summer 3-4 irrigations per month are necessary whereas during the remaining period, irrigation is given as and when required. About 20-25 irrigations are enough during a year.

WEEDING

In *Ocimum sanctum*, weeds like *Cyanodon dactylon* and *Cyperus rotundus* can be troublesome. Before transplanting deep ploughing has to be done and all the roots of the weeds are collected manually and removed. Under well managed conditions 4 or 5 weedings are enough.

PESTS AND DISEASES-

Ocimum sanctum is a hardy crop and no serious pests and diseases have been reported. In some situations like waterlogged conditions root-rot may occur. To avoid this, proper drainage system has to be maintained. If the problem becomes serious drenching has to be done with 3% neem seed kernel extract.

Under cloudy conditions it is noticed that incidence of Tingid bug namely *Cochlochilo bullita* (family *Tingidae*) can cause serious damage by sucking the sap from leaves and causing defoliation and ultimately death of whole plant. To avoid this, as a precautionary measure, a foliar spray of 0.2 % neem oil has to be given and the spraying is repeated every 15 days till clear weather prevails.

HARVESTING

Ocimum sanctum is ready for first harvest 90-95 days after planting. Subsequent harvests are taken approximately once in three months. For leaf production, the crop has to be harvested at flower initiation. The crop should be cut at 15-20 cm above the ground level. The harvesting is done in such a way that most of the tender shoots are cut leaving the woody stem portions for regeneration.



Harvesting *Ocimum sanctum* crop

POST HARVEST MANAGEMENT

Pharmaceutical companies prefer to buy dry herb for extraction of active constituents. For this *Ocimum sanctum* herb has to be shade dried for about 8-10 days by thinly spreading on gunny bags, preferably in well aerated drying sheds. The material must be turned over frequently to prevent fungal attack. The moisture content in the dried herb should be less than 10%.



Drying *Ocimum* herb

YIELD

From well managed organically grown *Ocimum sanctum* crop 12-15 t / ha fresh herb (equivalent to 2.4 to 3 t / ha dry matter) can be obtained in a year.

Bacopa monnieri

Bacopa monnieri is commonly known as Brahmi. The plant has been mainly prescribed for nervous disorders such as insanity, epilepsy, nervous breakdown etc. The plant is reported to be useful in treating biliousness, inflammations, tumours, ulcers, flatulence, constipation, asthma, bronchitis, skin diseases, leprosy, leucoderma, sterility, fever and general debility.

It has also been indicated as a cardiogenic and in treatment of snake bites.

Bacopa monnieri is a prostrate herb belonging to the family *Scrophulariaceae*. It is commonly found distributed in wet or marshy habitats and along the stream and river margins throughout India to approximately 1300 m elevation. In Kannada it is known as neer brahmi, in Telugu sambranichettu, in Tamil nirpirimi and in Sanskrit it is known as nira-brahmi.

Bacopa monnieri is reported to have the chemical constituents brahmine and hespestine. Mannitol and saponins were reported later. It contains mainly two saponins namely bacoside A and B; bacoside A is considered to be the most important active constituent.



Bacopa monnieri

PLANT DESCRIPTION

Bacopa monnieri is a creeping, diffusely branched, somewhat succulent herb, stem obtuse-angular, 10-30 cm long, rooting at the nodes; branches numerous, ascending, leaves sessile or short petiolated, ovate-oblong, 0.5-2.5 cm long end, 0.2-1 cm wide. Flowers are white to pale blue or violet, solitary, borne in leaf axils on slender pedicels 0.6-3.2 cm long, calyx glabrous divided to the base, sepals 6 mm long, corolla 8 mm long, fruits (capsules) 5mm long, ovoid, acute, included in the persistent calyx, seeds oblong and pale coloured.

SOIL AND CLIMATE

Bacopa monnieri plant is known to grow under varying soil and climatic conditions. The plant performs exceptionally well in poorly drained soils and waterlogged areas under subtropical conditions. The plants grow faster at high temperatures (30-40° C) and humidity (65-80%) and should be cultivated as summer rainy season crop in north India. Ideally, the plants should be transplanted in March-June and allowed to grow and proliferate through hot and humid months of monsoon till September after which harvest should be taken. In south India it can be grown throughout the year.

LAND PREPARATION

The field should be ploughed thoroughly and made free of weeds. Before planting, the field is dug up and the roots of weeds like *Cyperus*

rotundus are collected manually. The field is divided into plots of suitable size (eg 1 m × 3 m). One or two irrigations followed by removal of weeds may be necessary to minimize weeds. The soil should be moistened a day before planting by flooding for the successful establishment of plant cuttings.

VARIETIES

CIMAP, Lucknow has developed high herb and high bacoside-A yielding cultivars namely Subodhak and Pragyashakthi.

TRANSPLANTING

Before removing the cuttings from the nursery, nursery should be flooded. The plants are dug out taking care to minimize the damage to the roots of the cuttings. Plant cuttings about 6-8cm long, containing nodes with roots are used for transplanting. One day before planting, vermicompost is spread on the surface of the plots and mixed thoroughly with top 10 cm soil and then the land is flooded. The cuttings are transplanted in wet soil at a spacing of 15 × 15 cm. Flood irrigation should be provided immediately after planting.



Planting material



Preparing planting material



Planting

IRRIGATION

Irrigation immediately after the transplanting is essential for the successful establishment of the cuttings. *Bacopa monnieri* is a succulent and water loving plant. So irrigation should be given at 3-4 days intervals. There is no need for irrigation during the rainy days.

WEED CONTROL

At the time of land preparation, after deep ploughing all the weeds like *Cyperus rotundus* are collected manually. After crop establishment, weeding should be done with proper care to ensure that along with weeds, crop is not removed. So trained labours are necessary. Weeding implements like Kurpi should not be used for weeding. Weeding should be done by hand picking under wet soil conditions.

DISEASE AND PEST CONTROL

No major disease or pest problems are known for *Bacopa monnieri*. Insects like grasshoppers and *Spodoptera litura* have been seen in *Bacopa monnieri*. To control infestation by these insects 0.2% neem oil may be sprayed at 15 days intervals.



Harvesting *Bacopa monnieri* crop

HARVESTING

Harvesting is done when the crop has fully covered the ground (4 to 4½ months after planting). One week before harvest irrigation should be stopped. Then the crop is scrapped out and the herbage is separated from soil.

YIELD

Under well-managed conditions, *Bacopa monnieri* gives up to 10 ton/ha herb yield (equivalent to about 2 t dry material / ha).

POST HARVEST PROCESSING

After the harvest the herb is cleaned with fresh water to separate herb from soil. One or two thorough cleanings are required. After the cleaning, the herb is spread thinly on clean gunny bags in shade and allowed to dry. The material is turned over frequently to avoid fungal growth. About 8-10 days of shade drying is necessary at room temperature. There should not be any fungal growth and drying shed should be free from birds and rodents. The moisture content in the dried herb should be less than 10%. The dried material is packed in bags /boxes and stored in a cool dry room, away from the walls.



Drying *Bacopa monnieri*

ECONOMICS

Growing *Bacopa monnieri* as an intercrop in other crops like *Ocimum sanctum* is more profitable than growing it as monocrop.

S.No	Parameters	<i>Ocimum sanctum</i> as a sole crop.	<i>Bacopa monnieri</i> as a sole crop.	<i>Ocimum sanctum</i> + <i>Bacopa monnieri</i>
1	Duration (Months)	18	18	18
2	Herb Yield(t/ha) (Dry)	3.0	3.0	2.0 + 3.0
3	Gross Returns(Rs)	75000.00	54000.00	104000.00
4	Cost of cultivation (Rs)	14880.00	22700.00	32700.00
5	Net Returns(Rs)	60120.00	31300.00	71300.00
6	Additional income over sole crop of <i>Ocimum sanctum</i> (Rs).	—	—	11180.00
7	Additional income over sole crop of <i>Bacopa monnieri</i> (Rs).	—	—	40000.00
8	B: C Ratio	4.04 : 1	1.38 : 1	2.18 : 1

Price of Organically grown *Bacopa monnieri* herb Rs 18 /kg

Price of Organically grown *Ocimum sanctum* dried herb Rs 25 /kg.

When *Bacopa monnieri* is grown with *Ocimum sanctum* it gives an additional income of about Rs.40000.00 and Benefit : Cost Ratio of about Rs. 2.18 : 1.

MASS PRODUCTION OF VERMICOMPOST

Basic requirements for production of vermicompost.

- 1.Pit with shade.
2. Any decomposable wastes of plant origin(except spices).
- 3.Earthworms.
- 4.Seive (mesh pore size 2 mm)
- 5.Chopper for cutting wastes into small pieces



Vermicompost pit



Chopping wastes



Earthworms

Construct the pit with length 6 m, width 1.25 m and 0.5 m depth. To avoid seepage losses of nutrients plaster the bottom with cowdung. For 1 m x 1 m x 1 m pit 100 earthworms are required. At most care should be taken to see that there is enough shade to protect worms from direct sunlight and rain. The waste is cut with a chaff cutter into small pieces for faster composting. This waste should be free from plastic and glass pieces.

Earthworms : These worms are different from locally available earthworms in soil. These are organic matter feeders known as redworms. Worms which are commercially used are *Eisenia foetida* and *Eudrilus euginae*.

Important tips for vermicomposting are as follows:

- 1.Frequent sprinkling of water to maintain the moisture level to 30-40%.
- 2.Frequent turning over of the waste material.
- 3.When ready for harvesting vermicompost appears like tea powder. It is then sieved through a (approximately 2mm) sieve. The material that does not pass through the sieve is returned to the pit. It provides worms for the next batch. The sieved material should not be exposed to direct sunlight. It should be stored in gunny bags in a cool and dry place to keep its moisture intact.
- 4.Optimum temperature is for vermicomposting 20-30° C



Advantages of vermicompost :-

1. The process is cost efficient.
- 2.It is rich in N,P,K content(2 times more than FYM)
- 3.Its water holding capacity is very good.
- 4.It acts as a good multiplying media for many bioinoculants.
- 5.It is free from weed seeds

Dosage recommended :- For flower pots @ 200-50 g / pot.

For kitchen garden @ 0.5 kg / m²

For agriculture and horticulture crops @ 2-5 tons /ha.

BIOFERTILIZERS IN ORGANIC FARMING

These are beneficial microscopic living organisms isolated from soil or plant roots and artificially cultured. These bioinoculants are preparations containing microorganisms that supply nutrients, especially nitrogen and phosphorus, and may also benefit plants by producing plant growth promoting compounds. On the basis of nutrient supply these are broadly classified into two types; N and P. N supply is mainly from free living, symbiotic or with association symbiosis. P supply takes place through phosphate solubilisers and phosphate absorbers.

Commonly used micro organisms as a biofertilizers are,
For N : *Rhizobium* (symbiotic), *Azospirillum* (associative symbiosis), *Azotobacter* (nonsymbiotic).

For P : *Aspergillus* sps, *Penicillium* sps, *Bacillus* sps, *Pseudomonas* sps (P solublisers)

Glomus sps, *Gigaspora* sps, *Pisolithus* sps, *Rhizogogon* sps (P-absorbers).

Method of use of biofertilizers :-

Different biofertilizers with different trade name are available for use in agriculture universities, microbiology laboratories and organic farming institutions. It is important to see and follow the instructions, given on that packet. Accordingly, the biofertilizer is mixed with vermicompost and applied in the field. Vermicompost serves as a good multiplying media for microorganisms.

CROP ROTATION WITH LEGUMES :

Legumes improves soil fertility because of their nitrogen fixing ability .Growing legumes in rotation improves the mineral N content and N mineralization potential in the soil as well as soil-microbial activity, soil structure, water holding capacity, buffering capacity and release of growth promoting substances. Most commonly used legumes in crop rotation are groundnut, tur, clusterbean, greengram, mothbean, pea, dolichos etc.

GREEN MANURING

Green manures constitute a valuable source of organic matter and N. Legume crops have the ability to acquire N from the air with the help of their root-nodule bacteria. Green manures also add and increase the availability of several other plant nutrients though their favourable effects on chemical, physical and biological properties of the soil. A leguminous crop of 45-60 days can add up to more than 20kg N/ha when ploughed under ; generally it is around 10kg/ha green manure N, which corresponds to the average amount of mineral fertilizer N applied to the most of the crops and is as efficient as fertilizer N. The green manure crop also acts as mulch and provides protective cover against erosion and leaching. Green manuring thus helps to improve soil fertility and should be practiced wherever feasible.

The crops most commonly used for green manuring are :-

daincha, sunhemp, horsegram, berseem, senji, lucerne, phillipesora etc.

Sowing time of green manure crop :-

It is always better to sow the green manure crop much before or at least 30-45 days before the onset of monsoon. This may be done by providing one pre-sowing irrigation and the crop should be sown so that the turning may be done during active rain period to facilitate faster decomposition.



Dhaincha (a green manure crop)

Seed rate :-

Usually one and half times of normal seed rate is used in case of raising green manure crop. Accordingly about 4kg of sunhemp, 3kg of daincha, seeds are used per hectare. The seeds are usually broadcasted.

Crop	Quantity of green matter (Q/ha)	Nitrogen content (%)	Total amount of N added to the soil(kg/ha)
Sunhemp	190	0.43	84.0
Daincha	180	0.42	77.1
Berseem	140	0.43	60.7
Senji	267	0.51	134.4

GREEN LEAF MAURING

In this method green manure trees are grown elsewhere, as on bunds or in borders of the field, and the green leaves are stripped off the growing trees / bushes, transported to the site of green manuring and later incorporated there. The most suitable plant/tree sps of this group are Lucerne, *Albizia*, *Sesbania*, *Cassia* sps, Karanja etc.

Method of Green leaf manuring :-

When plants reach to flowering stage or they have crossed maximum vegetative growth (when they have achieved maximum foliage) then they are turned and incorporated in to soil. First of all the crop is planked then ploughed with soil turning. The field has to be irrigated and after about 7-10 days the field should be re-ploughed and irrigated. Thus within 25-30 days plants get decomposed and start releasing nutrients for the succeeding crop.

CONCENTRATED ORGANIC MANURES : The common concentrated organic manures are of both plant and animal origin. Usually Oil cakes are made of mainly castor, mahua, karanj, neem, safflower, cottonseed, groundnut, linseed, soyabean, niger, rapeseed, sesame and coconut.

Nutrient contents in oil cakes (% by weight)

Oil cakes	N	P	K
Linseed	4.9	1.4	1.3
Mustard	5.2	1.8	1.2
Groundnut	7.3	1.5	1.3
Sunflower	7.9	2.2	1.9
Sesamum	6.2	2.0	1.2
Niger	4.7	1.8	1.2
Coconut	3.0	1.9	1.8
Cotton	6.4	2.9	2.2
Castor	4.4	1.8	1.4
Karanj	3.9	0.9	1.2
Mahua	2.5	0.8	1.8
Neem cake	5.2	1.0	1.4