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Agronomic Practices for High Trade Value Indian Aromatic Plants

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Abstract India has long tradition of perfumery trade in the world. The art of perfumery flourished and enriched under the patronage of Moghul kings during their rule in India. The perfumers of Kannauj (U.P.) were famous for the product of aroma by distilling rose, kewra, agarwood, and sandalwood etc. This was possible due to abundant availability of raw material from plants resources either wild or cultivated. Of the 18000 species of plants distributed in India, 1300 are aromatic. Out of this 65 aromatic plant species have large and consistent demand. Cheaper synthetic fragrance suppressed the natural aromas due to price advantage, but blenders have now realized that the complex chemical components of each essential oil resourced from plants can no way be matched. In the present communication agronomic practices for 20 high trade value Indian aromatic plants are reviewed.
Keywords *Agronomic practices, Aromatic plants, Essential oil*

Introduction

Essential oils represent the ‘essences’ or odoriferous constituents of plants. There are also called volatile oils being volatile in steam and at high temperature evaporate. Besides medicinal/therapeutic applications (carminative, diuretics, local stimulants, mild antiseptics, local irritants, antiseptics, or parasiticides), they find commercial applications as spices, flavoring of foods, confections, beverages, cosmetics, tobacco etc.

Plant texa of angiospermic families are major source of essential oils. About 2000 species distributed over about 87 plant families reported to consist essential oil. Pinaceae, Lauraceae, Rutaceae, Myrtaceae, Apiaceae, Lamiaccae and Astraceae are chief families for source plant material. Certain essential oil (e.g. in the liver of fish, musk etc.) are also resourced from animals. Depending upon the localization of essential oil in plant parts, essential oils are extracted from different morphological entities viz. flowers, fruits, seeds, stem, leaves, whole plant etc. Essential oil occur in specialized secretory structures such as glandular hairs, modified parenchyma or oils cells, oil tubes or vittae, as well as in internal lysigenous or schizogenous passages or glands. Chemically these are variable in nature depending upon the presence of hydrocarbon, alcohol, ester, aldehyde, ketone, phenols, esters, oxides and peroxides, and terpenoid in constitution.

The growing demand of essential oil is putting a pressure on the existing resources owning to limitation on the existing sources and threatened natural habitats; cultivation of aromatic plant is inevitable. The listed plant species in Table 1, economically viable and essential oil resourced from them are commercially exploited for different applications. This compilation1-7 in agronomic practices of certain Indian aromatic plants is intended to provide basic essential information for farmers and extension works in Table 2.

Table 1: *Important Aromatic Plants Species and Their Utility Pattern*

S. No.	Botanical Name	Trade Name	Commercial Application
1.	*Cymbopogon flexuous & C. pendulus*	Lemongrass	The oils used in perfumery and cosmetic industry and also in manufacture of Vitamin A.
2.	*Cymbopogon winterianus*	Citronella	Oil obtained from steam distillation of leaves in rich in citronellal and geraniol and is used in perfumery, cosmetics and mosquito repellent formulations.
3.	*Cymbopogon nardus & C. confertiflours*	Cymbopgon	The essential oil is used in perfumery and flavouring industries.
4.	*Cymbopogon nardus C. confertiflorus & C. jwarancusa.*	Jamrosa	Freshly harvested foliage and flowering shoots yield 0.4 % essential oil on steam distillation, which is used in perfumery/flavour/soap industry. The oil is good substitute of palmarosa oil.
5.	*Cymbopogon martini*	Palmarosa	It is used in perfumery and cosmetic industries, flavouring of tobacco and in soaps.
6.	*Mentha arvensis*	Menthol mint	Oil is source of natural menthol used in flavour and pharmaceutical industries.
7.	*Mentha piperita*	Peppermint	The leaves on distillation yield essential oil (0.4-0.5%). The oil is used in perfumery, food flavouring and pharmaceutical preparations.
8.	*Ocimum canum*	Basil oil	The herb yields 0.5-0.7% oil, useful in perfumery and flavouring industry.
9.	*Ocimum gratissimum*	Clocimum	It yields about 0.5% oil with 80-85% eugenol therein, useful in flavouring, pharmaceutical industry and synthesis of vanillin.
10.	*Pelargonium graveolens*	Geranium	The eaves and branches are steam distilled to get “oil of geranium” (Aporrox. yield 0.8%-0. 1%), used in high-grade perfumery product and soaps.
11.	*Vetiveria zizanioides*	Vetiver	The roots are steam distilled to get vetiver oil, which used in high-grade perfumers.
12.	*Salvia scalaria*	Clary sage	The flowers yield 0.15-0.25% essential oil rich in linalool and linalyl acetata. The oil is used in high-grade perfumes, cosmetics, flavouring liquors and as modifier in spice compounds.

S. No.	Botanical Name	Trade Name	Commercial Application
13.	*Pogostemon patchouli*	Patchouli	Oil is used in perfumery and cosmetic industry as a fixative as it Provides tenacity to other perfumes.
14.	*Humulus lupulus*	Hops	The female inflorescence of the plant, called hop cones, is chiefly used in the manufacture of beer.
15.	*Lavendula angustifolia*	Lavender	The flowering tops of lavender plant yield 1.2% -1.4% valuable essential oil, mainly composed of linalool and linaly acetate. The oil is used in high-grade perfumery. Lower quality oil goes for preparation of lavender water, toilet water and soaps.
16.	*Apium graveolens*	Celery	The seeds contain 2%-2.5% aromatic oil, dry seeds are used as spic in fresh and processed foods e.g. soups,sauces,pickles,meat,vegetable juices and in form of oleoresins. The seeds are also used in pharmaceutical applications and manufacture of commercial drug 'Ajmoda' used in Unani and Ayurvedic system of medicine. Leaves and stalk are used as salad vegetables.
17.	*Cinnamomum verum*	Cinnamon	Quill (tender inner bark) is used as a spice and medicine. In addition, the bark oil (55% -56% cinnamic aldehyde) and leaf oil 75% -95% eugenol) are obtained which are used as food as food flavour and in manufacture of toothpaste, perfumery and cosmetics.
18.	*Eucalyptus* sp.	Eucalyptus	The leaves are steam for ex traction of essential oil (1.0%-1.2% yield) which is widely used in soap, perfumery, pharmaceutical, cosmetic industry and in the manufacture of citranellal, citranellol and hydroxyl citranellal. The wood is used as mine props, railway sleepers, in Paper/pulp industry and as fuel.
19.	*Artemisia annua*	Wormwood	The plant is a source of artimisinin used for the manufacture of arteether-drug for treatment of malaria; also yield essential oil (0.3%).
20.	*Rosa damascena*	Damask rose	Rose products are used in high value cosmetic, perfumery, food, pharmaceutical Industry, pan masala and tobacco.

Table 2: *Important Aromatic Plants Species and Their Agronomic Profiles.*

S. No	Botanical Name	Region	Climatic Environment	Propagation	Agripractices	Yield
1.	*Cymbopogon flexuous*	Tropical and sub-tropical plains.	Well-drained sandy loam, literate soil pH-5.5-9.0 and humid climate with sufficient sunshine.	Through vegetative slips during Feb / March, economic life: 4-5 yr.	Harvesting period May-Dec., 4-5 harvests/yr, 6-8 irrigation; fertilizer; N 150,P6O, K60, FYM 10t/ha.	In first 100-130 kg oil, second year onwards 175-200 kg oil/ha.
2.	*Cymbopogon winterianus*	NE region, southern region,Indo-gangetic plains	Well drained sandy loam or loamy soil, pH 5.8 - 8.0; sub-tropical to tropical climate, well-distributed rainfall 200-250 cm.	Vegetatively through slips during July / August and Feb / March ; about 55,000 slips/ha	Irrigation: 4-6 during rain free period, fertilizer: N-150, P60, K60 kg/ha/yr. Leaf blade is harvested 15 cm above the ground. First harvest comes 90 days after planting, subs equently at 3-4 months interval; economic life 4 yr	First yr: 150.2nd-3rd yr: 200,4th yr: 150 kg oil/ha.
3.	*Cymbopogon nardus*, & *C. confertiflours*	Northern and Central India	Sandy loam to loamy soil, ph range 6.5-8.5,tropical environmentcond itin, warm and humid climate with sufficient sun shine hours; 800 to 1500 mm annual rainfall.	Vegetatively through slips, 62,500 slips/ha. Planting period Feb/March, July/August.	1st cutting 130 to 150 days after planting, thereafter at 55 to 65 days interval; life span 4-5 yrs; irrigation: 8-10 per yr, fertilizers; FYM 10 t, N200 kg, P80 KG, k60 kg/ha.	1st year: 200-220 kg, 2nd year onwards: 250-280 kg oil/ha.
4.	*Cymbopogon nardus, C. confertiflorus & C. jwarancusa.*	UP and other region	Sandy loam, loam, wastes lands-tropical and sub-tropical. It can withstand water stress conditions though returns in irrigated conditions are higher.	Planting in Feb-March; 50,000 slip/ha.	Harvesting period: May to December at 90-95 days interval, 10 irrigation, fertilizer: N180, P60, K60 kg/ha.	First year: 160 KG and in second year onwards: 220 kg oil/ha.

S. No	Botanical Name	Region	Climatic Environment	Propagation	Agripractices	Yield
5.	*Cymbopogon martini*	All regions except temperate hilly areas.	Well-drained sandy loams to loamy soils are ideal; the plant survives in sodic soil at 5-9.5, sub-tropical and tropical climate. It can also be cultivated in degraded soil, eroded lands, as well as marginal soils with reasonable returns. Propagated during rainy season through seed: 10-12 kg/ha.	Propagated during rainy season through seeds: 10-12 kg/ha.	Fertilizers: N 100, P 50 kg/ha/year. In poor red soil of Deccan plateau, N up to 250 kg/ha gives good result.4-6 irrigation (during rain free period). The crop is harvested 3-4 months after planting; 2-3 harvests obtained in the first year and 3-4 in subsequently year. Economic life 4-6 year.	First year: 60-80 kg, second year onwards: 100-150 kg/ha.
6.	*Mentha arvensis*	Punjab, Haryana, UP, Uttarakhand, MP, Bihar, Rajasthan.	Well-drained deep loamy soil; pH 6.5-8.0,tropical and subtropical climate, rainfall 950-1050 mm.	Vegetative propagation through suckers; 5q suckers for direct sowing and 1q/ha suckers are required for nursery and transplantation of seedlings.	It is a 6-7 months crop. First harvest 100-120 days after planting, second harvest after another 50-60 kg/ha.	150 to 200 kg oil/ha.
7.	*Mentha piperita*	Terai region and hill of UP, Himachal Pradesh, Sikkim.	Well-drained, rich deep loam soils; semi-temperate climate, average rainfall 95-105 cm, average temp. 15-30 ^{0} C.	Through runners or other vegetative parts during mid Dec.-mid Jan.	First harvest 110-130 days after planting, second after another 8-12 weeks; life span 1 year; irrigation: 10-12, fertilizer; N 125 kg, P60 kg, K60 kg, FMY10 t/ha. The crop is generally allowed to wilt for 24-28 hr before distillation. This reduces moisture content; allow proper packing of herb and effects savings in steam during distillation.	Apporox. 100 kg oil/ha.

S. No	Botanical Name	Region	Climatic Environment	Propagation	Agripractices	Yield
8.	*Ocimum canum*	Punjab, UP, MP, Kerala, Tami Nadu.	Well-drained loam and sandy loam soil, tropical & subtropical climate; also grows on moderate acidic, saline and alkaline soil at Ph 6-8.	Through seed, 500 g/ha, planting in Feb-March and June-July.	Harvesting period: June, August to October; irrigation: 9; fertilizer N: P: K: 90:60:60, FYM 5 t/ha. It is a month crop.	180-210 kg oil/ha (during 7 months).
9.	*Ocimum gratissimu*	Punjab, UP, MP, Kerala, Bihar, Tamil Nadu.	Well-drained rich loam to poor laterite, saline and alkaline to moderately acidic soil, air to high rainfall and humid condition, tropical and subtropical climate at altitude up to 900m.	Through seed & tender cutting, planning material: 500 g/ha, transplanting during Feb-March and June-July.	First harvest 90-95 days after transplanting, thereafter at 65-75 days interval.2-3 harvests in the first year and 4 each in subsequent year during May, July, Sep, & Dec.Life span: 5year; irrigation: 8;fertilizer: FYM 10t,N: P: K: 90:60:60 kg/ha.	1^{st} year: 175-180, 2^{nd} year onwards: 200-250 kg oil/ha.
10.	*Pelargonium graveolens*	North and South India, both in plains and hilly region.	Well-drained fertile soil, pH: 5.5-7.5, and Mediterranean type of climate with warm winter and mild summer, average temp. 30-35^{o} C with low humidity, moderate rainfall up to 1000-1500 mm.	Through stem cutting, about 40000 plants/ha during November-February.	Harvest after about 5 months, subsequently at 3 months interval; grown as annual in North India Plains, up to 3 year in other irrigation as per need, fertilizer: 150-200 kg N, 60 kg and P60 kg /ha .2-3 weeding and regular hoeing are required.	30-35 kg oil/ha/year.

S. No	Botanical Name	Region	Climatic Environment	Propagation	Agripractices	Yield
11.	*Vetiveria zizanioides*	North and south Indian plains	Light loam or medium loam loose soil; tropical and subtropical climate. It can survive in highly alkaline soils up to pH 10 and also grow in riverbeds and water logged conditions.	Vegetatively through slips; planting during February and July-August; 40,000 slips/ha.	Roots are harvested 18-10 months after planting. Soils of medium fertility do not require fertilizer. For red laterite soils in South India, fertilizer N20, P40 kg/ha is required as basal dose at the time of planting. Vertiver is cultivated as a rain fed crop; 1-2 irrigation: required if planted during dry period.	12-15 kg oil from month's crop.
12.	*Salvia scalaria*	Kashmir valley, HP and Uttarakhand.	Poor, dry and slightly acidic soils, temperature climate, bright light and 8-33^0 C temp during harvesting in June/July	Through seeds in Nov. or March / April using 3-4 kg seeds/ha. Propagation through seedling gives better result. Seedling raised in March /April are transplanted in Nov. and raised in Aug. / Sept. is transplanted in next season.	Plant does not require irrigation. 100 kg N/ha is required in 3 split doses. 25 kg N, 30 kg, P and 30 kg K are applied as basal dose. Flowering tops are harvested twice/ye i.e. in July and Sept.; remunerative life: 4 yr.	20 kg oil/ha.

S. No	Botanical Name	Region	Climatic Environment	Propagation	Agripractices	Yield
13.	*Pogostemon patchouli*	NE India, Southern States where temperature is moderate.	Well-drained medium loam fertile soils are favourable,while tropical & subtropical regions are also Suitable.	Well-drained Medium loam Fertile soils are Favorable during Feb-April, Planting preferred in coconut	Spacing: 60cmχ60cmχ1m fertilizer: N 100, P 50, K50, K50 kg / ha, irrigation: 2-3 during Dec.-Feb. Perennial crop life span: 3-4 months interval. The leaves are dried in shade for 3-6 days. The leaves yield 1.8-3.0% oil on distillation. The plant in highly susceptible to root knot disease, which is controlled by adopting crop rotation and use of nematicides.	50 kg oil/ha.
14.	*Humulus lupulus*	Kashmir valley, Lahaul-Spiti in Himachal Pradesh and Champawat in Uttarakhand hills.	Sandy loam to clay loam pH 6-8.	Vegetatively through cutting, planted in Nov-Dec or March. Row to row and plant to plant spacing of 2m χ 2m each resulting in 2500 plants/ha with 5-6 m as the height of hop trellis.	Cow/mule dug or poultry manure is the traditional organic manure. Nitrogen is most important plant nutrient in addition to P & K along with micronutrients. After vines are trained, the field is irrigated repeatedly after picking; the cones are dried in a kiln, pressed and baled. The price of hops is determined by the concentration of alpha acids.	1st year: 2,500, 2nd yr: 5,000, 3rd yr: 6,250 kg/ha.

S. No	Botanical Name	Region	Climatic Environment	Propagation	Agripractices	Yield
15.	*Lavendula angustifolia*	Kashmir Valley, Uttarakhand.	Well aerated dry and calcareous soil rich in nutrients, pH 7.0-8.4; cold winter and cool summer; rainfall 550-700 mm in the form of rain or snow. It can also be grow on gentile and steep slopes, poor eroded soils.	Through seeds during Nov. /Dec. also propagated through rooted cutting. Seeds germinate in April at 14-15^0 Scatting of 10 cm length are taken from 1yr old plants and firmly planted. Beds are covered with black polythene on protect from cold weather.	A basal dose of 20 kg N and 40 kg N are needed. The field requires regular weeding and hoeing. Old lavender plantations are regenerated during winters. Harvesting of flowers is done in dry sunny days during Aug/Sept.Oil is extracted by steam distillation.	15 kg oil/ha.
16.	*Apium graveolens*	Punjab, Haryana, UP and hilly areas having cold and dry climate.	Sandy loam soils, cool climate, winter season.	Direct planting or seeding 1.5-2 kg seeds / ha. Nov. to May (6 months crop)	Harvesting period: 2nd and 3rd week of May, 3-4 irrigation, fertilizer: N 100, P 40, K10 kg/ha. Maturity in 180-190 days. The seed is harvested as soon as colour change takes place. It is sun dried and cleaned before packing.	2t Seeds/ha.
17.	*Cinnamomum verum*	Coastal areas of Kerala, Orissa, Tamil Nadu, Karnataka, Goa, Maharashtra.	Medium to loam soils with sufficient organic matter; tropical humid coastal climate with well distributed rainfall.	Through seeds during May/June. One year old seedling transplanted at a distance of 2mχ2m.	Irrigation requited during rain free period till 1 yr old; fertilizer: 100g NPK per plant in 1st yr, 200 g in 2nd yr and 500 g in subsequent yr. harvest: 2 yr after coppicing during July/Aug and Dec./Jan., remunerative returns after 10 yr. quill by products yield 0.8% bark oil while leaves yield 0.6-0.8 % oil on distillation.	Bark 250 kg/ha/yr, leaf oil 100 kg/ha/yr.

S. No	Botanical Name	Region	Climatic Environment	Propagation	Agripractices	Yield
18.	*Eucalyptus*	Most part of India up to 1500 mean sea level altitude.	Well drained deep sandy to sandy loam soil preferred; also survives in marginal acidic and gravellier soils; tropical & subtropical climate; rainfall 200-250 cm, humidity about 85%, temp 16-30^{o} C.	Through seeds during March/April, seedling transplanted after 40-45 days.	Fertilizer: N80, K20 kg/ha/yr, irrigation during dry months; clipping of twigs after 6 months from planting, thereafter harvest every 3-4 months. Remunerative life: 10 yr.	First yr: 80 kg oil/ha; subsequent yr: 170-200 kg oil/ha. Dry wood: 8-10 t/ha.
19.	*Artemisia annua*	Himalayan region, subtropical northern plains.	Sandy loam-to-loam soils with proper drainage; light textured soil ideal; temperate climate with cold winter and moderate summer. It can also be cultivated during winter in northern plains.	Through seeds: in temperate region during March/April, in northern plains during Oct.; 35 days old seedling are transplanted.	Fertilizer: N150, P50, K50 kg/ha.Irrigation: during summers in tropical region, regular in subtrop.region; water logging to be avoided. Crop is harvested during Oct.-Nov, in tropical and May-June in subtopic. Region .The herbage is immediately steam distilled for essential oil. If artimisinin is the desired product, herbage is shade dried leaves and flowers separated from stalks for processing.	Artemisinin 5kg/oil 55 kg.

S. No	Botanical Name	Region	Climatic Environment	Propagation	Agripractices	Yield
20.	*Rosa damascena*	Jwala and Noorjehan are suitable for sub-tropical northern plains, mid hills and mild temperate region up to 1200 m altitude.	Wide range of soil, sandy loam to clay loam. It does well in deep rich loamy soil.	Through stem cutting, water-shots and seeds. The rooted cuttings are transplanted during monsoon while winter is ideal for establishment in field.	Irrigation is necessary during dry periods. Fertilizer: N: 120-150, P: 60-90, K: 40-50 kg/ha/yr.Harvest: in northern plans during March/April and in the hills during May. Economic life: 15-20 yr.	Fresh flowers: 3.5-5.0 t/ha; Oil recovery: 0.0250.030 %; Oil yield: 0.75-1.5 kg/ha; Rose concrete: 0.35-0.45%; Rose absolute: 0.15-0.20%; Rose water: AAA 1800-2000L/ha and AA grade 3,500-4,000 L/ha.

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