

Cultivation of Vetiver

[*Vetiveria zizanioides* (Linn)]



ICAR – DIRECTORATE OF MEDICINAL AND AROMATIC PLANTS RESEARCH

BORIAVI, ANAND – 387 310, GUJARAT

Cultivation of Vetiver

[*Vetiveria zizanioides* (Linn)]

Compiled By

Smitha G. R.

Thania Sara Varghese

P. Manivel



ICAR – DIRECTORATE OF MEDICINAL AND AROMATIC PLANTS RESEARCH

BORIAVI, ANAND – 387 310, GUJARAT

Published by : Dr. Jitendra Kumar
Director,
ICAR – Directorate of Medicinal and Aromatic Plants Research,
Boriavi, Anand – 387 310, Gujarat

Phone : +91-0269-2271602
Fax : +91-0269-2271601
E-mail : director.dmapr@gmail.com
Web address : www.dmapr.org.in

Printed : December, 2014

Copies :

Front Cover :



Vetiver Grass



Vetiver Roots

Printed at : Anand Press, Anand 388 001, Gujarat
E-mail : anandpress@gmail.com

CONTENT

Forward

1	Name of the plant	7
2	Plant part employed in aromatic oil extraction	7
3	Characteristics of the plant	8
4	Major production areas	8
5	Characteristics of strain (s) for cultivation	9
6	Cultivation methods	9
7	Quality evaluation of essential oil	15
8	Comparative summary table of the characteristics of different cultivated varieties / strains	15
9	Cultivation calendar	16

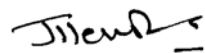
FOREWORD

VETIVER, commonly known as *Khus* grass is a perennial grass of Indian origin. Vetiver roots contain fragrant essential oil, which is a perfume by itself. Aroma chemicals such as vetiverol, vetiverone and vetiveryl acetate are prepared from this volatile oil. In India it is mainly used in perfumes, cosmetics, aromatherapy, food and flavouring industries. Since the plant has extensive finely structured fibrous roots, it is useful in both soil and water conservation and the plant itself is drought tolerant. The world production of vetiver oil is around 300 tons per annum of which India contributes about 20-25 tons only. The world major producers are Haiti, India, Java and Reunion. In India it is cultivated in the states of Rajasthan, Uttar Pradesh, Karnataka, Tamil Nadu, Kerala and Andhra Pradesh, with an annual production of about 20 tons of oil. The present consumption of vetiver oil in India is about 100 tonnes and 80% of the domestic consumption is met by export only.

As the internal demand for vetiver oil is very high, concerns are raising over the improved production and quality of raw materials used. Hence, I hope this extension bulletin will serve the farmers to take up vetiver cultivation and increase the production by following the proper cultivation practices. I am happy that ICAR- DMAPR, Anand has taken appropriate step to publish this bulletin that would serve as a useful guide for the vetiver growers of our nation.

Anand

November 24, 2014



(Jitendra Kumar)

Cultivation of Vetiver

[*Vetiveria zizanioides* (Linn)]



1. Name of the plant

- 1.1. Scientific name: *Vetiveria zizanioides* (Linn) Nash. (2n=20)
(Family: Poaceae)
- 1.2. Local name: *Usirah*, *Usira*, *Vira* (Sanskrit), *Khas*, *Khus* (Hindi); *Valo* (Gujarati); *Khas-khas* (Bengali); *Ramacham* (Malayalam); *Illamichamber* (Tamil); *Vattiveru* (Telugu); *Panni* (Punjabi); *Vala* (Marathi); *Khas* (Urdu)

2. Plant part employed in aromatic oil extraction

The commercial essential oil of vetiver is obtained by distillation of the roots.

3. Characteristics of the plant

Vetiver (*Vetiveria zizanoides* (Linn) Nash.) or *Khus* of family Poaceae, is a perennial grass which can grow up to 1 to 2 metres high and form wide clumps. The plant stems are erect and stiff and the leaves are 120-150 cm long and 0.8 cm wide and rather rigid. The panicles are 15-30 cm long, brownish-purple in colour and have whorled 2.5-5.0 cm long branches. The spikelets are in pairs, and there are three stamens. The root system of vetiver is finely structured and very strong. It has no stolons or rhizomes. Unlike most grasses, which form horizontally spreading mat-like root systems, vetiver's fibrous roots grow downward, 2-4 m in depth, and are strongly scented. Vetiver is mainly cultivated for the fragrant essential oil distilled from its roots. The main chemical components of the oil are benzoic acid, vetiverol, furfural, vetivone and vetivene. Due to its excellent fixative properties, it is used widely in perfumes. Dry roots are also used for making mats, fans, screens, pillows, baskets, incense sticks and sachet bags.

Since plant has extensive fibrous roots, it is useful in both soil and water conservation. It helps in maintaining soil moisture, absorbs toxic substances in chemical fertilizers and pesticides and improves physical characteristics of soil. The plant is one of the best soil binders and is used through tropics to check soil erosion by planting along contour. Grass is also widely grown as a protective partitions in terraced fields and as a border for roads and gardens.

4. Major production areas

Vetiver is indigenous to India, Pakistan, Bangladesh, Sri Lanka and Malaysia. Its main producers are Tropical Asia, Africa, Australia, Haiti, Indonesia, Guatemala, India, China and Brazil. Crop is also cultivated in Indonesia, Malaysia, Philippines, Japan, Angola, Belgian Congo, Dominican Republic, Argentina, British Guiana, Jamaica, Mauritius and Honduras. Worldwide production is estimated to about 250 tons per annum.

In India, it is seen growing wild throughout Punjab, Uttar Pradesh and Assam. It is systematically cultivated as a crop in the states of

Rajasthan, Uttar Pradesh, Kerala, Karnataka, Madhya Pradesh and Andhra Pradesh. Annually 20-25 tonnes of oil is produced in India. Uttar Pradesh produces the highest quantity of oil, mainly through wild sources. Vetiver oil produced in North India is of premium quality and fetches a very high price in international market.

5. Characteristics of strain (s) for cultivation

In India, two types of vetiver namely ‘South Indian’ and ‘North Indian’ are generally under cultivation. North Indian types yields superior quality oil but its rooting finds to be shallow, especially in damp ground. South Indian types are the cultivated types with a thicker stem, less branching roots and wider leaves. It is non-seeding type, high yielding both in terms of root bio mass and oil. It is reproduced by vegetative propagation and it is the type suitable for erosion control.

Among South Indian types, Pusa Hybrid-7, Hybrid-8, CIMAP-KS-2, Sugandha, KH-8, KH-40 and ODV-3 are varieties available for commercial cultivation. Cultivars Dharini, Gulabi and Kesari released by CIMAP, Lucknow were developed by repeated selection of germplasm collections from different parts of India.

6. Cultivation methods

6.1 Soil

Vetiver can be grown on almost every kind of soil. However, light soils, should be avoided as the roots grown in this soil produce very low percentage of oil. Well drained sandy loam and red lateritic soils rich in organic matter are considered to be ideal for cultivation. It can also be cultivated in clay loam soil but it is better to avoid clayey soil. It can be grown in wide pH range even in saline and alkaline soils with a pH of 8.5 to 10. A flat site is acceptable, but watering must be monitored to avoid water logging, that will stunt the growth of young plantlets. Mature vetiver, however, thrives under waterlogged conditions. It can also absorb dissolved heavy metals from polluted water and can tolerate arsenic, cadmium, chromium, nickel, lead, mercury, selenium and zinc.

6.2 Climate

Vetiver is tolerant to a wide range of temperature ranging from -15 °C to +55 °C, depending on growing region. The optimal soil temperature for root growth is 25 °C. Root dormancy occurs when temperature goes below 5 °C. Under frosty conditions, shoots become dormant and purple, or even die, but the underground growing points survive and can regrow quickly if the conditions improve. Shading affects vetiver's growth, but partial shading is acceptable. It is tolerant to drought, flood, submergence and grows luxuriantly in places having moderately humid climate with annual rainfall of 1000 to 2000 mm. It can also be grown as an irrigated crop in other suitable places with scanty rainfall.

6.3 Propagation

Vetiver can be propagated either by seeds or slips, but slips are commonly used. The cultivated accessions which are propagated through vegetative means show limited variation, whereas, seed propagation is used for breeding new varieties. In North Indian types, profuse seeding and natural regeneration occurs from self sown seeds. Seed yield varies between 400-650 kg/ha. Freshly collected spikelet show dormancy and require an after-ripening period of about 3 months. Removal of caryopsis from enclosed husk facilitates germination. Dormancy can also be broken by treating the seeds with gibberlic acid or potassium nitrate.

In South Indian types, most of the spikelets are not subjected to fertilization and seeds which sometimes produced are very thin and are having a short dormancy period. In these non-seeding types, slips are separated from clumps of previous crops with rhizome portion intact having 15-20 cm of aerial portion is used for propagation. Slips thus obtained should be kept moist and stored in shade. Dry leaves should be removed from slips before transplanting to avoid carry over of pests and diseases.

6.4 Planting time

The most suitable time for planting vetiver is June – August with the onset of monsoon. In South Indian conditions, where diurnal

variation in temperature is not significant and monsoon sets in early and the optimum planting time is February-April.

6.5 Land preparation

Land is ploughed to a depth of 20-25 cm by 2-3 deep ploughings and remove the perennial weeds. Recommended dose of farm yard manure or compost and fertilizers are applied and mixed well with the soil. In sloppy areas pits are taken across the contour.

6.6 Planting

The mother clumps can be divided in to small pieces to give many number of slips. Slips are separated from the clump with the rhizome portion intact having 15-20 cm of the shoot portion. While planting slips fibrous roots and leaves should be trimmed off.

Ensure planting of slips at the correct time. Slips from healthy and disease free clumps are planted during June-July with the onset of monsoon vertically about 10 cm deep at a spacing of 60×30 cm / 60 × 45 cm / 60 × 60 cm based on soil fertility status, climate, variety and irrigation facility. Plant population varies from 27,800 to 1,10,000 plants/ha. If irrigation facilities are available, it is better to plant during March-April, and frequent irrigation will be required. Late planting resulted in the production of coarse roots which yield inferior quality oil.

6.7 Crop nutrition

Normally, fertilizer application for vetiver is not practiced in fertile soils. But, on poor soils, 10 tons of FYM along with 25-50 kg/ha each of N, P₂O₅ can be applied. Care should be taken to apply N in 2-3 split doses. N:P₂O₅:K₂O dose of 60:22.5:22.5 is recommended in Kerala. Application of 60 kg P₂O₅/ha is suggested for vetiver cultivation in Central Uttar Pradesh.

6.8 Irrigation

In the absence of rainfall, soil moisture status should be maintained by irrigation from planting to establishment. In the areas where rainfall is good, well distributed over the year and humidity is high,

supplementary irrigation is not necessary. However, in dry areas about 8-10 irrigations will be required to get the optimum yield. Apply mulch to conserve soil moisture. Irrigation should be discontinued 7-10 days before harvesting.

6.9 Intercultural operation

In case of newly established crop, 2-3 weeding and earthing-up at an interval of one month are needed during initial period of plant growth. Once the crop is established, weeds are kept under check because of vetiver's thick and dense shoot cover. Aerial portion is trimmed at 20-30 cm above ground level thrice during the entire cropping period of two years. First trimming should be done at 4-5 months after planting, second during second year just before flowering and third in second year winter season, about one month before digging of roots.

6.10 Plant protection

Insect pests

Vetiver is a hardy crop and infestation by pests is not a serious concern. However, in dry areas termites are seen damaging the crop. Grubs of beetle *Phyllophaga serrata* have also been reportedly infesting vetiver roots. These can be controlled by broadcasting neem cake @ 5 t/ha before final ploughing. Stem borer, *Chilo sp.* and scale insects are also a threat in some places to the commercially grown vetiver. Remove the leaves and plants severely infested by scales and spraying with neem oil 5% also reduces scale infestation. Nematode infestation of roots by is also reported. To prevent nematode infestation caused by *Heterodera zaeae*, use nematode free healthy mother stock. High organic matter content of the soil, hot water treatment and application of neem cake @ 5 t/ha are also found effective in controlling nematode.

Diseases

During rainy season the plant is infested by *Fusarium sp.* Leaf blight caused by *Curvularia trifolii* is another important disease during rainy season. The infested leaves bear tan to dark spots which turn

black with age. The roots of affected plants become yellow and gradually dry out. These pathogens can be controlled by 2-3 spraying or drenching of copper oxy chloride 0.3%.

6.11 Harvesting

The time of harvesting of vetiver roots is very important as the yield of roots and oil percentage vary with changes in environmental conditions. Roots are harvested after 15-24 months of planting, but to obtain good quality oil it should be harvested at 18 months. Though, early harvesting gives higher essential oil yield, oil will be of low specific gravity which also lack valuable high boiling constituents. If roots stay in ground for over two years, oil quality improves but yield diminishes considerably. Crop is generally harvested during December - February by digging out the clumps along with its roots manually. A tractor drawn mould board plough can also be used for digging out roots up to 35 cm depth. Mechanical harvesting gives 15% higher roots recovery over manual harvesting.

6.13 Processing

The harvested roots are separated from the aerial parts, washed thoroughly, chopped to shorter lengths of 5-10 cm to facilitate easy drying and then dried under shade for 1-2 days before distillation, which improves the olfactory quality of the essential oil, while prolonged sun drying reduces the oil yield. While drying, roots should be laid out in thin layers and this will prevent the chances of fungal growth that results in decomposition of root. Do not dry the roots on the ground in direct sunlight without close supervision as direct sunlight involves a high risk of degradation of its active principles.

After drying, the oil is extracted from the roots through hydro or steam distillation. In North Indian varieties, distillation process is completed in 12-14 hours, while South Indian varieties require a long duration of 72-96 hours, as it has low volatile oil and high boiling point. Two distinct fractions, one lighter than water and another heavier than water are obtained from vetiver. Heavier the

oil better is the quality. After distillation is completed these fractions should be collected separately and later mixed together. The oil is then decanted and filtered. The distilled oil is treated with anhydrous sodium sulphate or common salt at the rate of 20 g/litre to remove the moisture. Oil obtained from stored roots is more viscous and posses a slightly better aroma than that obtained from freshly harvested roots. Fresh roots require less time for distillation and gives maximum oil yield.

The vetiver oil is amber brown and rather thick. Its odour is described as deep, sweet, woody, smoky, earthy, amber and balsam. Ageing of the essential oil for a period of six months improves the odour of the oil substantially wherein, the 'harsh' 'green' and 'earthy odour' characters of the freshly distilled oil gets converted in to a fuller, heavier and sweeter odour. The oil should be stored in sealed amber coloured glass bottles or containers made of stainless steel, galvanised tanks, aluminium containers and stored in a cool and dry place. All processing activities should be documented in a diary.

6.14 Expected yield

The essential oil yield of vetiver roots varies considerably and it depends on a number of factors such as soil conditions, age of the roots, harvesting time, drying and distillation methods followed etc. On an average the root yield may range from 3-4 tonnes per hectare from a two year old plantation. In sandy and sandy loam soils, root yield is as high as 2-2.5 tonnes /ha whereas; in salt affected areas only 1-1.5 tonnes of roots can be harvested per hectare. The average oil recovery from north Indian variety is between 0.15 to 0.2%, whereas, it is 1% from South Indian variety. Oil recovery from fresh roots is 0.3-0.8% and from dried roots it is 0.5-3.0% depending upon the duration of distillation. On an average the oil recovery is around 1% on dry weight basis and 10-30 kg oil is obtained per hectare per crop.

7. Quality evaluation of essential oil

The vetiver oil should have the following specifications

Parameters	South Indian	North Indian
Colour	Brown	Reddish green
Specific gravity at 30 °C	0.990 - 1.015	1.512 - 1.523
Optical rotation	+10° to +25°	-50 ° to -132°
Refractive index at 30 °C	1.516 - 1.530	1.512 - 1.523
Saponification value	25-50	25-80
Saponification value after acetylated oil	125 - 155	145 - 200

7.1 Gas Liquid Chromatography composition of vetiver oil:

Vetiver oil or *khus* oil is complex oil containing over 100 identified components, mainly sesquiterpenes. The characteristic constituents were vetiverol (45-80%), β -vetispirene (1.6-4.5%), khusimol (3.4-13.7%), vetiselinenol (1.3- 7.8%) and vetivone (2.5- 6.3%). Besides these components trace amounts of benzoic acid, vetivene, furfural, khusemene, khusimone, β -humulene, valencene, β -vetivone, selinine etc. are also present in the oil.

8. Comparative summary table of the characteristics of different cultivated varieties / strains

KS-1	:	Essential oil yield 17.8 kg/ha
Sugandha	:	Yields 21.2 q fresh roots/ha, 1.4% oil content and 19.7 kg ha oil yield / ha
Hybrid-8	:	Root yield 12-15 q/ha, 1% essential oil content and possess 70-85% vetiverol
Keshari	:	Saffron flavoured, oil yield 30 kg/ha
Gulabi	:	Has a rosy odour, tolerant to sodic soil, yields 2.8 t dry roots and 25-30 kg/ha of essential oil, can be cultivated in marginal soils and waste lands
Dharini	:	Possesses longer, thicker and dense roots, tolerant to sodic soil, is a good soil binder and useful for soil and water conservation, oil yield 39 kg/ha

9. Cultivation calendar

Major activity	Month	Activity details
Land preparation	May – June	2-3 deep ploughing & removal of perennial weeds
Manure and fertilizer application	May - June	Application of basal dose of recommended dose of FYM/ compost and fertilizers
Plantation	June - July	Slips from healthy, disease free clumps with rhizome portion intact having 15-20 cm of aerial portion are planted at a spacing of 60×30 cm/60×45 cm/60×60 cm
Irrigation	June - July	Irrigation should be given immediately after transplanting and up to establishment. Later on 8-10 irrigations are required throughout the cropping period.
Fertilizer application	July - August	Application of first top dressing of nitrogen 25 kg/ha at one month after planting
Intercultural operations	July - August	2-3 weeding and earthing up at an interval of one month during initial period of establishment
Intercultural operations	October - November	Trimming of aerial portion at an height of 20-30 cm above ground 4-5 months after planting
Intercultural operations	March - April	Trimming of aerial portion at an height of 20-30 cm above ground just before flowering
Fertilizer application	March - April	Application of second top dressing of nitrogen 25 kg/ha
Intercultural operations	October - November	Trimming of aerial portion at an height of 20-30 cm above ground one month before digging
Harvesting	December - February	Digging the clumps along with its roots at eighteen months after planting either by manual or mechanical means.



भारत
ICAR