

## PRIMARY AND SECONDARY CENTRES OF ORIGIN OF VETIVER AND ITS DISPERSION

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### Introduction

The genus *Vetiveria* is a small genus of perennial grasses occurring mainly in tropical countries of the old world. In India, only two species of this genus, namely *V. zizanioides* and *V. lawsonii* (Ramanujam and Kumar 1964), are found to occur in nature, of which the former is of great significance. In India this plant is known to have been in use both for its fragrant oil and as traditional medicine since antiquity (Husain 1984; Husain et al. 1984). Multifarious medicinal uses of this plant are on record in ancient Ayurvedic treatises by Charaka, Vagbhadananda and others (Masood 1958). Copper plate inscriptions dating from 1103 AD and 1174 AD have been discovered in Etawah (Uttar Pradesh) listing “Khus oil” (as it is called in north India) as royal articles under use by the king of Kannauj (Shukla 1957). The name “vetiver” is derived from the Tamil word *vetivern* (Tamil is spoken in the South Indian state of Tamil Nadu). All this indicates that the Indians were the first to recognize vetiver for its aromatic and medicinal uses, followed by its other cottage and environmental uses in India and elsewhere.

Despite all this it had earlier been considered that the centre of origin of vetiver seemed to lie either in Africa or Australia, where diverse forms are frequently encountered under humid tropical conditions (Ramanujam and Kumar 1964).

### The Indian Subcontinent as the Primary Center of Origin

#### Morphotaxonomic Perspective

In India, this perennial, densely tufted grass is found naturally occurring throughout tropical and subtropical plains, particularly along riverbanks and over marshy lands. It has a wide range of ecological distribution, from sandy seacoasts and swamps to plains and foothills (Husain 1984; Lavania 1998) and also on the hilltops up to elevations of 800 m in the Kumaun hills of Uttar Pradesh (R.K. Lal, pers. comm.) sustaining subzero temperatures. Two distinct morphological complexes are found to inhabit spatially separated geographical regions, one in North India and the other in South India. Whereas in the north the plant grows wild along the Indo-Gangetic plains and other adjoining areas, mainly in the states of Rajasthan, Madhya Pradesh, Uttar Pradesh and Bihar, in the south it is wild along the east and west coasts of the Indian peninsula in the states of Andhra Pradesh, Karnataka, Tamil Nadu and Kerala. The two races distinctly differ with respect to plant morphology, reproductive habit, root architecture and essential oil characteristics. Whereas the North Indian population exhibits profuse flowering, supports high seed set and produces high-grade laevorotatory essential oil from its smooth roots, the vetiver population in the south has late and low flowering and low seed setting and produces inferior-grade dextrorotary essential oil from rootlet-bearing roots (Sadgopal 1960; Lavania 1998; Lavania and Kumar 1998). The latter is also true for neighbouring Sri Lanka. Presence of a primitive character such as occurrence of mainly male florets in a particular collection (Kumar 1963) and also low and late flowering encountered in the south Indian population indicate that this plant may have appeared earlier in South India.

In addition to the Indian subcontinent, vetiver grows wild in subtropical and tropical areas in other South Asian countries, but the plant type resembles more the South Indian population with respect to reproductive behaviour and essential oil composition. However, a higher order of genetic diversity with respect to ecological/geographical adaptation, morphometric traits, reproductive behaviour and essential composition is found in the Indian subcontinent, followed by Indonesia (Lal et al. 1997). This plant has also become naturalized in the Reunion Island, but there it is reported to have been

introduced from Indonesia in late 18th century (Wildner 1960). DNA fingerprinting based on RAPD analysis performed on a world collection of vetiver germplasm by Adams and Dafforn (1998) has revealed that natural variability attendant in vetiver is confined to tropical Southeast Asia. This suggests that South Asia is the natural home of vetiver, of which India is the primary centre from where it may have dispersed to other South Asian areas. It may have evolved in Australia and Africa later as a secondary course of evolutionary mechanisms.

### **Cytotaxonomic Perspective**

Although morphotaxonomic affinities and phytogeographic parameters are important pointers to elucidate origin and divergence with respect to evolutionary history, chromosomal data could offer valuable insights in understanding the pattern of variation and affinity in closely related taxa. The divergence and evolution of angiosperms is often accompanied by large-scale changes both in amounts of chromosomal DNA and in structural re-patterning in chromosomal organization (Lavania and Sharma 1983; Bennett and Leitch 1995). The present author has extensively studied variation in nuclear DNA content and structural organization of chromosome complement in a large number of vetiver accessions representing geographical diversity (Lavania 1985).

Application of karyo-evolutionary parameters could be a valuable tool to deduce infra-specific specialization. Quantitative delineation of karyo-evolutionary changes can closely underpin the direction of evolutionary change vis-à-vis geographical distribution and morphotaxonomic diversity. The standard ways to phylogenetically grade chromosome changes are through depiction of karyotype symmetry (Stebbins 1971) and chromosome dispersion index (Lavania and Srivastava 1999). Whereas the former takes into account the extent of variation in chromosome size and arm ratio in the complement, the latter covers the gradual change in arm length variation within the complement. Increase in karyotype symmetry shows increased chromosomal specialization; and integration of the dispersion index serves as an adjunct to deduce quantitative differentiation vis-à-vis specialization.

The exhaustive data collected by the present author on karyomorphology and nuclear DNA amount (Lavania 1985) exhibited occurrence of tremendous infra-specific karyotype diversity in vetiver. However, the range of karyotype variation encountered could be sorted out in four karyotypic groups. Employment of chromosomal parameters of karyotype symmetry and dispersion index has facilitated to grade them in karyo-evolutionary groups (Table 1, Fig. 1). These data suggest that the most primitive, basal karyotype is found in the population from South India (Travancore collection), its next evolved stage is in a population from North-West India (Bharatpur collection) and the further evolved in down South East Asia (Reunion collection introduced from Indonesia) on the one hand and the North-Central India (Ghaghra Ghat collection, near Beehraich, Lucknow) on the other hand. It is, therefore, surmised that vetiver may have its origin in peninsular India (South India), from where it has digressed in different directions; in the north substantiating its reproductive specialization coupled with change in essential composition, and in south diversifying morphological features but retaining major essential-oil characteristics (Fig.1).

### **Summary and Conclusion**

South Asia is the natural home of vetiver as evident from its established morphogenetic differentiation and occurrence of high genetic and ecological diversity attendant in the native population. But as far as the reproductive and chemical diversity is concerned, it is at a maximum in the Indian subcontinent. This obviously indicates that the Indian subcontinent is most likely to be the centre of origin of vetiver, from where the plant may have dispersed to other areas. At intra-specific level, such an assumption could be better substantiated by studying the pattern and trend in chromosomal differentiation.

Exhaustive data obtained on vetiver collected from different geographical zones of India, and a collection from the Reunion Island (an introduction from Indonesia), revealed a tremendous amount of karyotype diversity in terms of chromosome morphology and in number and form of nucleolar

chromosomes. The attendant chromosomal diversity could be broadly clustered into four karyotypic groups. On the basis of standard chromosomal evolutionary parameters, it is observed that the most symmetrical and primitive karyotype is found in vetiver inhabiting the South Indian peninsula, suggesting this area to be the primary centre of origin. Further divergence in vetiver has taken place from the latter in two directions: (i) towards the north in the warm and dry northwest and the warm and humid east-central Indian plains and (ii) towards Southeast Asia and other parts of the world. The pace of evolutionary differentiation has been faster in warm and humid zones.

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