

Correlation and association of characters in *Vetiveria zizanioides* (L.) from Kerala part of Peninsular India

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Abstract

Selection of appropriate genotypes based on characters that show good genetic strength is a very important tool in crop improvement since selection could not be carried out based on all characters. Study of interrelationship and association of characters is essential to identify the variables which show maximum relationship with others. Correlation analysis was carried out presently in the case of 12 morphometric characters in vetiver (*Vetiveria zizanioides*) so as to study the relationship between them. The present study revealed varying degrees of interrelationship between the morphometric characters studied. Character association was also studied so as to group the characters based on gene sharing and to identify the lead characters that could be used in further breeding programmes. Plant height showed the highest factor loading followed by leaf breadth, root length, leaves per tiller and fresh root weight showing their higher contribution towards the variability of the population and their usability in breeding programmes as lead characters.

Highlights

- Correlation of the characters and association of agronomic characters have been studied in 14 varieties of *Vetiveria zizanioides*.
- Character association leads to grouping the characters based on gene sharing.
- Characters showing highest factor loading contribute maximum variability of the population and these characters can be used in further selection programmes.
- Agronomic characters of plants show different levels of association since they are polygenic.

Keywords: Vetiver, genotypes, interrelationship, correlation analysis, morphometric characters

Vetiveria zizanioides, commonly known as vetiver grass, is a perennial species belonging to the family Gramineae. It originated from India and Africa (Xia *et al.* 1998). Vetiver is an economically, pharmaceutically and ecologically important plant. Roots of vetiver yield essential oil that is used as a basic material for perfumery and cosmetics (Champagnet *et al.* 2006; Massardo *et al.* 2006). It has strong ecological

adaptability and resistance to drought, water logging, cold, heat, acidity and alkalinity. Meanwhile, it has some other good traits such as a strong root system, fast growth, easy planting and high survival rate, and it never turns into a weed, because it cannot be pollinated and fertilized. In the past, the utilization of the vetiver grass was limited to the extraction of the fragrant oil from the root (Cheng 1998).

Table 1. Variability of morphometric characters in the vetiver accessions studied.

Sl. No.	Accession	Plant height (cm)	Number of tillers	Tiller girth (cm)	Leaves per tiller	Leaf length (cm)	Leaf breadth (cm)	Root length (cm)	Number of roots per tiller	Fresh weight-shoot (g)	Fresh weight-root (g)	Dry weight-shoot (g)	Dry weight-root (g)
1	ODV-4	106.667	15.333	0.757	6.133	52.533	0.800	89.333	31.333	17.256	9.168	6.135	3.926
2	ODV-26	116.333	18.333	0.717	5.733	71.633	0.760	77.333	24.667	16.689	10.612	6.271	4.940
3	ODV-5	91.667	22.000	0.663	4.467	59.200	0.683	56.333	25.000	14.610	9.796	7.322	6.434
4	ODV-18	87.333	14.333	0.723	6.580	50.033	0.763	96.333	23.333	11.596	7.463	5.622	4.883
5	Periavura	109.667	11.000	0.707	5.670	78.940	0.787	117.00	45.000	13.354	21.794	4.617	7.422
6	Madapalli	99.667	13.667	0.610	4.847	59.457	0.780	124.667	25.333	9.678	11.671	3.524	3.934
7	Pandimedu	121.667	14.667	0.620	5.367	77.273	0.677	71.667	40.000	20.132	13.339	8.226	6.586
8	ODV-23	106.000	14.333	0.633	4.767	87.513	0.580	86.000	25.667	11.850	9.537	4.481	4.786
9	ODV-16	81.000	13.333	0.660	5.800	51.963	0.667	57.000	17.333	6.478	14.383	5.172	5.233
10	ODV-27	121.333	7.667	0.677	4.533	78.557	0.787	59.000	25.000	15.990	7.562	4.870	3.405
11	ODV-20	94.000	20.000	0.600	5.900	69.213	0.523	38.333	51.000	15.378	11.943	6.517	6.376
12	ODV-24	83.333	13.000	0.633	6.100	59.120	0.607	53.667	30.667	10.924	7.663	4.389	3.573
13	ODV-8	99.667	6.667	0.797	5.600	74.103	0.630	63.333	10.000	8.738	4.004	4.031	3.087
14	ODV-30	92.333	17.333	0.677	4.800	77.867	0.697	86.000	22.000	13.113	9.422	4.776	4.061

Table 2 . Correlation analysis of morphometric characters of *Vetiveria zizanioides*- correlation coefficients.

	Plant height	Leaf length	Leaf breadth	Number of tillers	Leaves per tiller	Tiller girth	Root length	Number of Roots per Tiller	Fresh weight-root	Fresh weight-shoot	Dry weight-root	Dry weight-shoot
Plant height	1											
Leaf length	0.610594*	1										
Leaf breadth	0.378829	-0.21901	1									
No. of tillers	-0.23433	-0.22292	-0.21378	1								
Leaves/ tiller	-0.30691	-0.51685	-0.01593	-0.0474	1							
Tiller girth	0.10113	-0.10813	0.413227	-0.38293	0.325894	1						
Root Length	0.204255	0.025032	0.644252*	-0.16665	-0.0278	0.150325	1					
No of Roots / Tiller	0.249522	0.175314	-0.14386	0.324126	0.185488	-0.46798	-0.00344	1				
Fresh weight root	0.15638	0.132333	0.190961	0.131797	0.032481	-0.29409	0.363399	0.601814*	1			
Fresh weight shoot	0.701024*	0.289842	0.196928	0.34411	-0.09278	-0.07657	-0.08926	0.560539*	0.108238	1		
Dry weight root	0.103052	0.115062	-0.1002	0.467781	0.039243	-0.32283	0.027968	0.669791*	0.77451*	0.338231	1	
Dry weight shoot	0.248389	-0.09309	-0.07202	0.598146*	0.080019	-0.14382	-0.38082	0.407062	0.134	0.730278*	0.587392*	1

**Table 3. Correlation analysis of morphometric characters of *Vetiveria zizanioides* - characters correlated.**

Sl. No.	Character	Characters correlated	Number of characters correlated
1	Plant height	Leaf length, fresh weight- shoot	2
2	Leaf length	Plant height	1
3	Leaf breadth	Root length	1
4	Number of tillers	Dry weight- shoot	1
5	Leaves per tiller	Nil	0
6	Tiller girth	Nil	0
7	Root length	Leaf breadth	1
8	Number of roots per tiller	Fresh weight- root, fresh weight- shoot, dry weight- root	3
9	Fresh weight-root	Number of roots per tiller, dry weight- root	2
10	Fresh weight- shoot	Plant height, number of roots per tiller, dry weight- shoot	3
11	Dry weight- root	Number of roots per tiller, fresh weight- root, dry weight- shoot	3
12	Dry weight- shoot	Fresh weight- shoot, dry weight- root	2

Table 4. Factor analysis in *Vetiveria zizanioides* - eigen values, percentage of total variance, cumulative eigen values and cumulative percentage of variance

Eigen value	% Total variance	Cumulative eigen value	Cumulative% of variance
3.642403	30.35336	3.642403	30.35336
2.417783	20.14819	6.060186	50.50155
1.878536	15.65447	7.938723	66.15602
1.624195	13.53496	9.562918	79.69098

Table 5. Factor analysis in *Vetiveria zizanioides*- factor loadings

Characters	Factor 1	Factor 2	Factor 3	Factor 4
Plant height	-0.387419	0.800093	-0.290446	-0.238622
Leaf length	-0.262334	0.507822	-0.641989	0.301717
Leaf breadth	0.112490	0.686507	0.517065	-0.261687
No of tillers	-0.573921	-0.494207	0.078531	-0.136862
Leaves/ tiller	0.090637	-0.318354	0.619626	-0.318474
Tiller girth	0.490039	0.330730	0.238441	-0.539921
Root length	0.100166	0.626757	0.536721	0.299711
No of roots/ tiller	-0.827819	-0.017404	0.164818	0.154404
Fresh weight- root	-0.596684	0.215680	0.484907	0.501260
Fresh weight- shoot	-0.730909	0.316760	-0.179221	-0.528508
Dry weight- root	-0.833437	-0.087504	0.291080	0.206237
Dry weight- shoot	-0.743574	-0.214119	-0.022294	-0.556135

**Table 6. Factor analysis in *Vetiveria zizanioides*- characters associated**

Factors	Characters associated
I	Tiller girth
II	Plant height , leaf length, leaf breadth, root length, fresh weight- shoot
III	Number of tillers, leaves per tiller , number of roots per tiller, dry weight- root
IV	Fresh weight- root

Generally it propagates by producing new shoots at the joints above the soil surface and by branching at the joints below soil surface that have inflorescence. The seeds are very thin and have a short dormancy period.

Genetic diversity plays an important role in crop improvement, because the segregants between lines of diverse origin generally display an improved performance than those between closely related parental genotypes (Hariram and Appalaswamy, 2014). As in the case of other crops, most of the agronomic characters are quantitative in nature in this species also. Such characters show interrelationship due to sharing of alleles. Polygenic characters show association between them and factor analysis is a very efficient tool used to find out character association and to group the variables in to different groups and also to effect data reduction by identifying the lead variables of each group (Hrideek *et al.* 2008; Umamaheswari and Mohanan, 2011). Presently, interrelationship and association of characters in *Vetiveria zizanioides* have been analyzed in the case of the morphometric characters for the purpose.

Materials and Methods

The present experiment was designed to analyze the variability among different accessions of *Vetiveria zizanioides* (L.). The experiment was carried out in Kerala Forest Research Institute, Peechi, Thrissur Kerala, India during 2011- 2013. The study area was located at an altitude of 80 m above MSL at 10°31' 51.4" N latitude and 07° 20' 47.58" E longitude enjoying humid tropical climate. Fourteen accessions of *V. zizanioides* collected from different parts of Kerala were raised and observed for the study. The

experiment was laid out in randomized block design with three replications and 12 plants per replication. Observations on twelve growth characters were recorded for three consecutive seasons starting from the first year and analysed. Data on Plant height (cm), Number of tillers, Tiller girth (cm), Leaves per tiller, Leaf length (cm), Leaf breadth (cm), Root length (cm), Number of roots per tiller, Fresh weight of shoot (g), Fresh weight of root (g), Dry weight of shoot (g) and Dry weight of root (g) were used for the study.

Statistical Analysis

Correlation of the characters has been analysed as per Rangaswamy (1995) and Msaakpa and Obasi (2014). Association of agronomic characters has been studied as per Sneath and Sokal (1973) by factor analysis using the statistical software STATISTICA.

Results and Discussion

Twelve morphometric characters that are important in the study of growth and yield behaviour of *Vetiveria zizanioides* were recorded (Table 1) and analysed presently so as to assess the interrelationship and association of the characters. Study of interrelationship of characters by correlation analysis is an important tool used to identify the variables which show maximum relationship with others in the case of polygenic characters. Correlation analysis was carried out presently in the case of 12 morphometric characters in vetiver so as to study the interrelationship between them (Tables 2 and 3). Among the characters plant height showed significant positive correlation with two characters (leaf length and fresh weight of shoot). Leaf length showed significant positive correlation



with plant height. Leaf breadth showed significant positive correlation with root length. Lal *et al.* (2013) and Srivastava and Lal (2012) also reported that the leaf photosynthetic rate showed significant positive association with root biomass in *Vetiveria zizanioides*. Number of tillers showed significant positive correlation with dry shoot weight. Root length showed significant positive correlation with leaf breadth. Number of roots per tiller showed significant positive correlation with three characters (fresh root weight, fresh shoot weight and dry root weight). Fresh root weight showed significant positive correlation with two characters (number of roots per tiller and fresh root weight). Fresh shoot weight showed significant positive correlation with three characters (plant height, number of roots per tiller and dry shoot weight). Dry root weight showed significant positive correlation with three characters (number of roots per tiller, fresh root weight and dry shoot weight). Dry shoot weight showed significant positive correlation with fresh shoot weight and dry root weight. This type of interrelationship is due to sharing of common alleles among them since the characters are governed by polygenes. Characters that show significant positive correlation are considered to be interrelated and thus can be jointly considered in selection programmes. The inherent linkage between various traits has been reported by correlation analysis in other plants also (Sunil Kumar, 2014).

When subjected to factor analysis, four factors could be extracted in the case of the twelve morphometric characters of *Vetiveria zizanioides* in the present study (Tables 4, 5 and 6). Among the characters tiller girth was grouped under factor I; plant height, leaf length, leaf breadth, root length and fresh weight-shoot grouped in factor II; number of tillers, leaves per tiller, number of roots per tiller and dry weight-root under factor III and fresh root weight under factor IV. Characters with the highest factor loadings can be considered as lead characters in each group based on which selection could be practiced. Plant height showed the highest factor loading followed by leaf breadth, root length, leaves per tiller and fresh root weight showing their higher contribution towards

the variability of the population. Such characters can be used as lead characters in further selection programmes in the case of *Vetiveria zizanioides*. Genetic variability and association analysis for yield and yield components in indigenous and exotic collections of vetiver was done by Lal (2000). He reported that plant height by itself may be a good direct selection criterion to obtain promising lines with longer roots in vetiver aiming at a better oil yielder and a good soil binder. Agronomic characters of plants show different levels of association since they are polygenic.

Similar analyses have been carried out by earlier workers so as to bring out the interrelationship of polygenic plant characters and their association with similar objectives. Hrideek *et al.* (2008) and Umamaheswari and Mohanan (2011) also highlighted the importance of such studies in understanding the relationship between characters and also in finding out lead characters which could be concentrated upon in future breeding programmes.

Conclusion

This type of interrelationship showed in the study is due to sharing of common alleles among them since the characters are governed by polygenes. Characters that show significant positive correlation are considered to be interrelated and thus can be jointly considered in selection programmes. Grouping of characters based on factor loading by factor analysis is an effective measure to reduce the number of variables based on which selection could be practiced. The present study will also be useful in designing future studies in such lines so that further explorations on the interrelationship and association of morphometric characters in *Vetiveria zizanioides* are carried out.

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References

- Bandi Hariram Kumar and Appalaswamy A 2014. Principal Component and Cluster Analysis of Fibre Yield in Roselle (*Hibiscus sabdariffa* L.). Citation: *International Journal of Agriculture, Environment and Biotechnology* 7(2): 255-260. DOI: <http://dx.doi.org/10.5958/2230-732x.2014.00242.3>
- Champagnet P, Figuerdo G, Chalchat JC, Bassiere JM 2006. A study on the composition of commercial *Vetiveria zizanioides* oils from different geographical origins, *Journal of Essential Oil Research* 18: 416-422.
- Cheng H 1998. The study on growth characteristics of vetiver grass. In: Xu LY(ed) *Vetiver Research and Development, Science and Technology Press of China Agriculture*, Beijing 35-38.
- Hrideek TK, Radhakrishnan VV, Mohanan KV, Kuruvilla KM, Madhusoodanan KJ, Thomas J 2008. A study of character association in small cardamom (*Elettaria cardamomum* Maton). *International Journal of Plant Breeding and Genetics* 2(1): 42-46.
- Kumar, Sunil 2014. Genetic variability, Heritability, Genetic Advance and Correlation Coefficient for Vegetative and Floral Characters of Gerbera (*Gerbera jamesonii*). *International Journal of Agriculture, Environment and Biotechnology* 7(3): 527-533. September 2014 DOI : <http://dx.doi.org/10.5958/2230-732x.2014.01357.6>
- Lal RK 2000. Genetic variability and association analysis for yield and yield components in indigenous and exotic collections of vetiver (*Vetiveria zizanioides* L.Nash) *Journal of Spices and Aromatic Crops* 9(2) : 133-136.
- Lal RK, Gupta P, Gupta V, Sarkar S, Singh S 2013. Genetic variability and character associations in vetiver (*Vetiveria zizanioides* L. Nash) *Industrial Crops and Products*. 08/2013; 49:273-277. DOI: <http://dx.doi.org/10.1016/j.indcrop.2013.05.005>
- Massardo DR, Senatore F, Alifano P, Guidice LD Pontieri P 2006. Vetiver oil production correlates with early root growth. *Biochemical Systematics and Ecology* 34: 376-382.
- Msaakpa TS, Obasi MO 2014. Correlated Studies between Growth and Yield Characters of Castor Bean (*Ricinus communis* L.). *International Journal of Scientific and Research Publications* 4(7):1-10
- Rangaswamy S 1995. Manufacture of black and green tea in India, Sri Lanka and Africa. In: N.K.Jain (ed.), *Global Advances in Tea Science*. Aravali Books International (P) Ltd., New Delhi: 745-760.
- Sneath PHA and Sokal RR 1973. *Numerical Taxonomy*. Freeman, San Francisco, USA
- Srivastava NK, Lal RK 2012. Variations among commercial cultivars of *Vetiveria zizanioides* in the photosynthetic and metabolic characters associated with essential oil accumulation. *International Journal of Medicinal Plant Research* 1(4): 045-049.
- Umamaheswari R, Mohanan KV 2011. A study of association of agronomic characters in *Vanilla planifolia* Andrews. *International Journal of Plant Breeding and Genetics* 5(1): 53-58. DOI: <http://dx.doi.org/10.3923/ijpbg.2011.53.58>
- Xia HP, Ao HX, He DQ 1998. Effect of vetiver grass in soil amelioration and water and soil conservation. In: Xu LY (ed) *Vetiver Research and Development, Science and Technology press of China Agriculture*, Beijing 101-106

