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Principal component analysis and cluster analysis in Indian bean (*Lablab purpureus* L.)

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Abstract
Indian bean is an important legume as well as vegetable crops cultivated in the tropical region of Asia, Africa and America. A study was carried out on a set of 50 genotypes of Indian bean during late *kharif* 2016-17. Seventeen quantitative traits were used to determine variability available between them and to identify principal components. Out of 17 characters, five principal components (PC_1 to PC_5) contributed 80.32% of total variation. Among these five principal components the green pod yield per plant, days to first picking, number of pods per plant, seed yield per plant and pod width was contributed greater towards variation in first, second, third, fourth and fifth principal component, respectively. Fifty genotypes of Indian bean grouped into five clusters based on D2 statistics. The maximum inter cluster distance was observed between cluster III and IV (29.31). The attributes *viz.*, pod length, pod width, days to maturity and number of pods per plant would be useful for heterosis breeding as they contributed maximum towards total genetic divergence.

Keywords: principal components, D^2 statistics and Indian bean

Introduction
Grain legumes occupy a unique position in the World Agriculture by virtue of their high protein content and their capacity of fixing atmospheric nitrogen.*Lablab purpureus* (L.) (Syn. *Dolichos lablab* L., 2n=22) is an important legume as well as vegetable crop cultivated in the tropical region of Asia, Africa and America. It belongs to the family *Fabaceae*,sub family *Faboideae*, tribe *phaseoleae*, and the genus *Lablab* included several distinct species but is currently regarded as monospecific. The crop has multipurpose use. It is one of the excellent pod vegetable crops grown in India. The green pods and tender leaves are popular vegetables. Its fresh green pod contains 86.1% moisture; 3.8% protein; 6.7% carbohydrates; 0.7% fat; 0.9% mineral matter and vitamin-A 312 I.U. (Singh *et al.*, 2004) [9], while mature dry seeds contain 23% protein; 62% carbohydrates and 340 calories per 100g of edible portion (Tindall, 1983) [11]. Field bean is remarkably adaptable to wider area under diverse climate conditions such as arid, semi-arid, sub-tropical and humid regions where temperatures vary between 22^0 and 35^0C, low land and uplands and many types of soil with pH varying from 4.4 to 7.8. It is a drought tolerant crop, which comes up well with the rainfall between 600 and 800 mm per annum (Yadav, 2003) [12].

In determining the potential of genetically different lines and cultivars, the plant breeders have to observe many different characters that influence final yield. Accurate evaluation of these characters is made more difficult by the genotype x environment interaction. Principal component analysis helps researchers to distinguish significant relationship among the traits.Genetic variation for morphological traits has been estimated using principal component analysis, which has led to the recognition of phenotypic variability. This approach is very helpful in identifying and deciding major contributing traits toward yield.In plant breeding, genetic diversity plays an important role because hybrids between lines of diverse origin, display greater heterosis than those between closely related parents and may generate broad spectrum of genetic variability in segregating populations (Arunachalam, 1981) [2].With this view present experiment was conducted with two main objectives. First,to identify few major contributing traits towards total variation based on principal component analysis. Second, to find out the extent of genetic diversity among Indian bean genotypes through Mahalanobis D^2 technique.

Materials and Methods

The present investigation was conducted to assess principle component analysis and genetic divergence in Indian bean at the Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh during late *kharif*2016-17.The experimental material consisted of 50 diverse genotypes of Indian bean (*Lablab purpureus*L.) obtained from the Vegetable Research Station, Junagadh Agricultural University, Junagadh.Fifty genotypes of Indian bean were sown on 27th September, 2016 in a randomized block design with three replications. Each line had ten plants of single genotype which was sown with a spacing of 75 cm × 45 cm. The genotypes were randomly allotted to the plots in each replication. The experiment was also surrounded by two guard rows to avoid damage and border effect. All the recommended agronomical practices along with necessary plant protection measures were followed timely for the successful raising of the crop. Data were recorded for days to 50 per cent flowering, days to maturity on the plot bases as well as days to first flowering, reproductive phase duration, days to first picking, days to last picking, number of picking, plant height, number of branches per plant, number of pods per plant, pod length, pod width, 10-green pod weight, green pod yield per plant, number of seeds per pod, 100-seed weight and seed yield per plant on five randomly selected competitive plants from each entry. Selected plants were tagged before the emergence of first flower. There were two sets of plants in each entry. First five plants were used for recording observations on green pod and the remaining plants were kept for recording observations based on seed related traits and their averages were used in the statistical analysis. The analysis for principal component was carried out by MINITAB software and analysis for genetic divergence was carried out using Mahalanobis's (1936) [5] D^2 statistics and grouping was performed as per Tocher method as described by Rao (1952).

Result and Discussion

Principal Component Analysis

As a multivariate statistical technique, the principal components analysis (PCA) has the ability to transform a number of possibly correlated variables into a smaller number of uncorrelated variables called principal components. The eigenvalues are often used to determine how many factors to retain.If the characteristic value is lower than one, it explains that the explanatory power of principal components is lower than the average explanatory power of the original variables. Generally, if eigen value is higher than one, it can be used as an inclusion criterion.

In present investigation five principal components PC_1 to PC_5, which are extracted from the original data and having eigen value greater than one, accounting 80.32% of the total variation. However, remaining 12 components contributed only 19.68% of total variation for this set of 50 Indian bean genotypes. These principal component scores might be used to summarize the original 17 variables in any further analysis of the data. PCA for the first five principal components of these data are given in Table 1.

Table 1: Principal Components (PCs) analysis for metric traits in Indian bean genotypes

Principal component	Eigenvalue	Variability (%)	Cumulative (%)
PC 1	4.65	27.36	27.36
PC 2	3.84	22.57	49.94
PC 3	2.73	16.06	66.00
PC 4	1.33	7.80	73.80
PC 5	1.11	6.52	80.32

PC_1 to PC_5 showed 27.36%, 22.57%, 16.06%, 7.80% and 6.52% variability among different traits under experimental genotypes. Among five principal components first two components revealed major contribution (49.93%) towards total variation.

Eigen value and variance associated with each principal component decreased gradually and cumulative variability increase gradually which is depicted as scree plot in Fig 1.The result of principal components is depicted as a factor loading score. This score is given in Table 2.

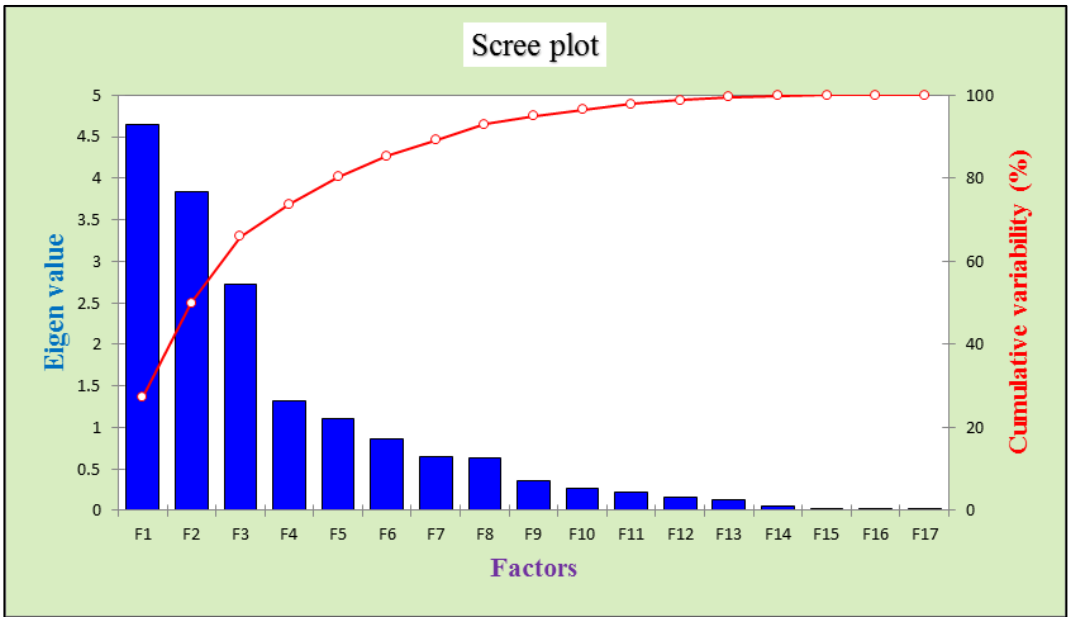

Fig 1: Relationship between eigenvalue and cumulative variability as scree plotfor 17 traits in Indian bean

Table 2: Factor loadings of principal components for on 17 characters in 50 Indian bean genotypes

S. No	Variables	PC_1	PC_2	PC_3	PC_4	PC_5
1	Days to first flowering	-0.590	0.760	-0.023	0.117	0.137
2	Days to 50% flowering	-0.592	0.760	0.005	0.106	0.164
3	Days to maturity	0.373	0.765	0.210	-0.351	-0.092
4	Reproductive Phase Duration	0.774	0.221	0.201	-0.418	-0.202
5	Days to first picking	-0.506	0.791	0.028	0.158	0.178
6	Days to last picking	0.171	0.744	0.514	-0.229	-0.086
7	Number of picking	0.552	0.195	0.650	0.211	-0.213
8	Plant height	0.026	0.628	-0.264	0.147	-0.095
9	Number of branches per plant	-0.093	-0.138	-0.312	0.511	-0.382
10	Number of pods per plant	0.215	-0.061	0.819	0.336	-0.210
11	Pod length	0.346	0.407	-0.683	-0.051	-0.229
12	Pod width	0.598	0.033	0.004	0.040	0.656
13	10-green pod weight	0.797	0.027	-0.312	0.054	0.341
14	Green pod yield per plant	0.845	0.012	0.181	0.298	0.205
15	Number of seed per pod	0.448	0.325	-0.479	0.081	-0.287
16	100-seed weight	0.598	0.195	-0.542	-0.065	-0.076
17	Seed yield per plant	0.427	0.319	-0.014	0.616	0.044

The variables effective in the first factor had a high level of loading coefficients and contribute much more on the response structure. Here, the first principal component (PC_1) had high positive component loading from green pod yield per plant followed by 10-green pod weight, reproductive phase duration, 100-seed weight, pod width and number of picking. On the other hand, high negative component loading was observed in $PC_1$with days to 50 per cent flowering, days to floweringand days to first picking. Here negative component loading indicated that selection for the earliness traits were effective from PC_1. This revealed that PC_1 contributed maximum variability due to earliness related traits as well as yield contributing traits. The major contributing characters for variation in the second principal component (PC_2) were days to first picking, days to maturity, days to first flowering, days to 50 per cent flowering, days to last picking and plant height.Likewise, the important traits *viz.*, number of pods per plant, number of pickingand days to last pickingcontributed more variation for PC_3. Similarly, seed yield per plant and number of branches per planthad more variation in PC_4 and only pod width for PC_5.

Usually, only one variable was selected from these identified groups. Hence, for the first group green pod yield per plant was best choice, which had the largest loading from PC_1. Likewise, days to first picking, number of pods per plant, seed yield per plant and pod width was the best choice for second, third, fourth and fifth principal component, respectively.Days to first picking contributed maximum variation for PC_2 was found in accordance with Sarkar and Kundagrami (2016) [8] in mungbean. Likewise, Aondover *et al.* (2013) [1] in soybean and Thippani *et al.* (2017) [10] in mungbean also recorded that number of pods per plant and seed yield per plant depicted greater variation in PC_3 and PC_4, respectively. Pod width determined more variation in PC_5 and this was supported by Kujur *et al.* (2017) [4] and Nayak *et al.* (2017) [6] in Dolichos bean.

A principal component loading plot in Fig 2 indicated the distance of each variable with respect to PC_1 and PC_2 which contribute maximum variation to total variation showed the contribution of these variables in the variation of 50 genotypes used.

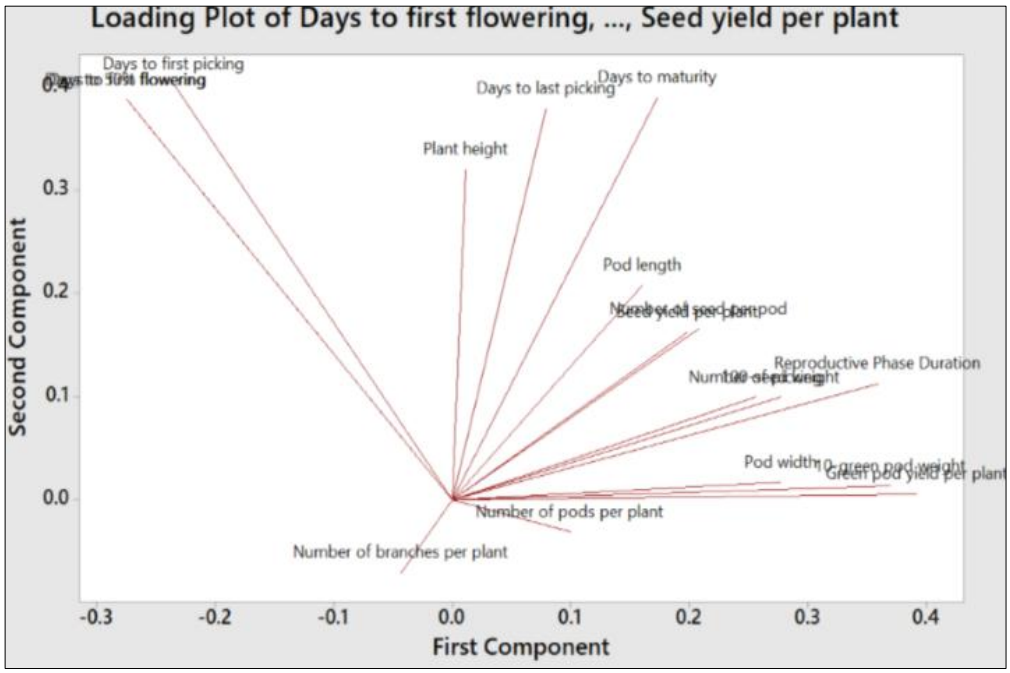

Fig 2: Distance of each variable with respect to PC_1 and PC_2

Cluster Analysis

In the present study, D^2 statisticswas estimated on 50 Indian bean genotypes for 17 characters. On the basis of D^2-values, five clusters were formed from 50 genotypes which is shown in Table 3 and dendrogram showing graphical representation of clusters is presentedin Fig 3.The cluster I and II contained four and three genotypes, respectively. The cluster III and IV contained fifteen and ten genotypes in each. On the other hand, cluster V possessed highest number of (eighteen) genotypes.

Table 3: Grouping of genotypes of Indian bean using cluster analysis

Cluster number	Number of genotypes	Name of genotypes
I	4	1 (GP-8), 49 (GP-154), 2 (GP-9), 18 (GP-30)
II	3	9 (GP-17), 17 (GP-26), 41 (GP-81)
III	15	3 (GP-10), 4 (GP-11), 32 (GP-63), 35 (GP-69), 11 (GP-19), 10 (GP-18), 12 (GP-20), 19 (GP-32), 22 (GP-37), 40 (GP-42), 15 (GP-24), 38 (GP-77), 50 (GP-155), 30 (GP-60), 37 (GP-76)
IV	10	5 (GP-12), 34 (GP-68), 6 (GP-13), 42 (GP-85), 8 (GP-16), 29 (GP-57), 39 (GP-78), 7 (GP-15), 47 (GP-136), 48 (GP-153)
V	18	13 (GP-21), 45 (GP-114), 46 (GP-124), 26 (GP-48), 36 (GP-75), 31 (GP-62), 14 (GP-23), 21 (GP-34), 23 (GP-42), 16 (GP-25), 27 (GP-49), 20 (GP-33), 44 (GP-92), 24 (GP-46), 28 (GP-56), 33 (GP-65), 43 (GP-159), 25 (GP-47)

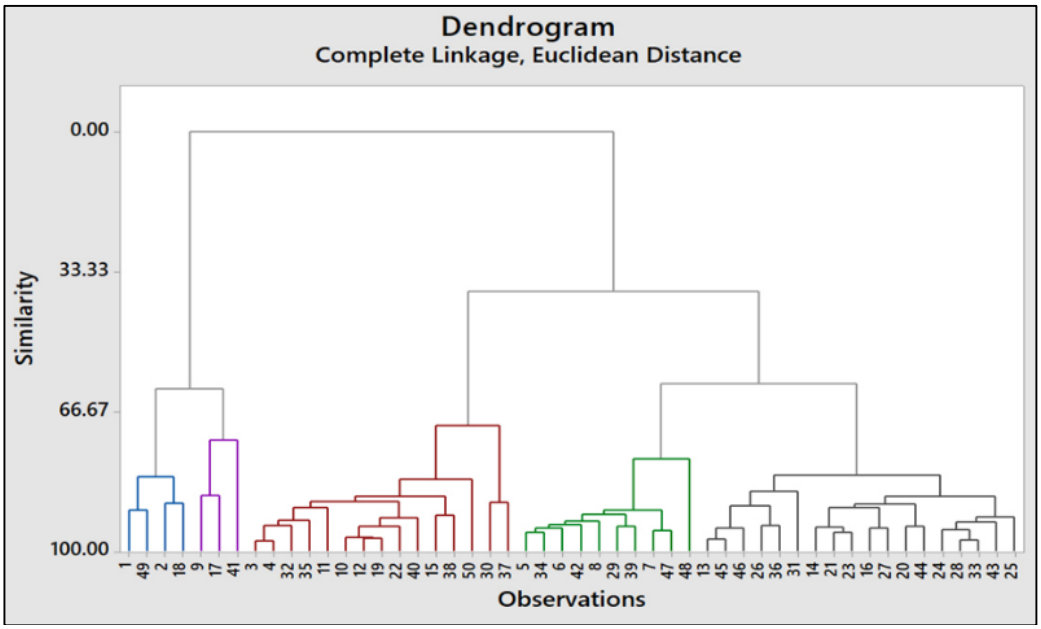

Fig 3: Dendrogram showing relationship among different cultivars of Indian bean

Their intra and inter-cluster distances are presented in Table 4. In general, intra cluster distances were lower than the inter-cluster distances and this was in accordance with Birari and Ghanekar (1992) [3] and Salim *et al.* (2013) [7]. Thus, the genotypes included within a cluster tended to less diverse from one another. The intra-cluster distance (D) ranged from 7.98 (cluster-III) to 11.61 (cluster-IV). High intra-cluster distance indicated the wider genetic diversity among the genotypes which could be used in genetic improvement of Indian bean. The maximum inter-cluster distance (D) was found between cluster III and IV (D=29.31) followed by that between IV and V (D=26.16), while the closest proximity was noticed between cluster III and V (D=13.26). The genotypes belonging to the clusters separated by high statistical distance could be used in hybridization programme for obtaining a wide spectrum of variation among the segregates or to exploit maximum level of hybrid vigour in Indian bean.A wide range of variation for several characters among multi-genotypic clusters was observed and presented in Table 5. However, the most important trait causing maximum genetic divergence was observed in pod length (41.80%) and was responsible for differentiating the genotypes studied. Pod width (13.71%), days to maturity (12.33%) and number of pods per plant (10.86%) were the next important traits contributed towards total genetic divergence. A considerable diversity of 78.70% was observed due to these four characters. Hence, selection for divergent parents based on these four characters would be useful for heterosis breeding in Indian bean. This result was in accordance with Birari and Ghanekar (1992) [3].

Table 4: Average intra (diagnol and bold) and inter-cluster distance values (D^2) in Indian bean

Clusters	I	II	III	IV	V
I	85.81 (9.27)	257.66 (16.05)	603.74 (24.57)	256.99 (16.03)	428.76 (20.71)
II		87.89(9.37)	353.56 (18.80)	508.85 (22.56)	182.17 (13.49)
III			63.83(7.98)	859.02 (29.31)	175.86 (13.26)
IV				134.70 (11.61)	684.12 (26.16)
V					72.07(8.48)

Table 5: Cluster means for different characters in Indian bean

S. No	Variables	Clusters					Mean	SEm	% Contribution towards total genetic divergence
		I	II	III	IV	V			
1	Days to first flowering	64.88	56.35	63.43	71.38	69.11	66.76	1.08	7.51
2	Days to 50% flowering	64.75	56.66	63.46	71.30	69.07	66.75	1.14	0.00
3	Days to maturity	170.00	178.66	166.06	162.20	171.83	168.44	1.24	12.33
4	Reproductive Phase Duration	105.25	122.00	102.62	91.03	102.83	101.75	1.63	0.00
5	Days to first picking	86.00	81.11	86.57	90.47	89.77	88.13	1.51	0.08
6	Days to last picking	154.92	157.44	155.53	149.56	158.40	155.44	1.99	0.08
7	Number of picking	10.58	12.00	10.91	8.53	9.74	10.05	0.37	0.41
8	Plant height	137.08	146.24	129.91	128.74	138.96	136.5	5.27	6.78
9	Number of branches per plant	4.58	4.71	4.57	4.78	4.52	4.61	0.29	0.00
10	Number of pods per plant	202.10	246.13	221.21	145.27	162.97	185.14	18.69	10.86
11	Pod length	9.26	8.96	8.13	8.21	8.72	8.45	0.16	41.80
12	Pod width	1.86	1.97	1.47	1.20	1.35	1.42	0.04	13.71
13	10-green pod weight	45.15	53.51	28.59	19.06	24.57	27.16	1.66	0.41
14	Green pod yield per plant	820.59	1070.27	564.38	280.52	394.98	485.6	41.26	0.98
15	Number of seed per pod	4.28	4.46	4.18	4.06	4.22	4.19	0.18	0.08
16	100-seed weight	35.16	46.28	37.68	32.69	34.24	35.65	1.54	4.00
17	Seed yield per plant	120.67	151.71	124.53	86.07	95.09	109.25	9.35	0.98

Clustering pattern indicated that most of the desirable characters for achieving high pod yield were present in cluster II.Cluster I was differentiated from other clusters in respect of pod length, while cluster IV was the best for days to maturity and number of branches per plant. Cluster V had desirable mean values for days to last picking.

In conclusion, principal component analysis revealed that out of 17 components five components were act as principal components as they had eigen value greater than unity and contributed 80.32% variation to total variation. D^2 analysis revealed five clusters from 50 genotypes. Cluster II was superior than other clusters for most of the yield contributing traits. Pod length, pod width, days to maturity and number of pods per plant contributed much towards total genetic divergence. Hence, selection for divergent parents based on these four characters would be useful for exploitation of heterosis breeding in Indian bean if commercially feasible or to isolate desirable segregants in segregating generations.

References

1. Aondover S, Lekan BL, Terkimbi V. Correlation, path coefficient and principal component analysis of seed yield in soybean genotypes. Inter. J Adv. Res. 2013; 1(7):1-5.
2. Arunachalam V. Genetic distance in plant breeding. Indian J Genet. 1981; 41:226-236.
3. Birari SP, Ghanekar SL. Genetic diversity in Lablab bean. J. Maharashtra Agric. Univ. 1992; 17(2):257-260.
4. Kujur P, Bahadur V, Shrivastava R, Kumar A. Assessment of genetic divergence using Mahanalobis D^2 and principal component analysis in Dolichos bean (*Lablab purpureus* L.). Veg. Sci. 2017; 44(2):62-65.
5. Mahalanobis PC. On the generalized distance in statistics. Proc. Nat. Inst. Sci. 1936; 2:49-55.
6. Nayak NJ, Maurya P, Maji A, Chatterjee S, Mandal AR, Chattopadhya A. Estimation of genetic parameters and selection of parents for hybridization in Dolichos bean (*Dolichos lablab* L.). Int. J Curr. Microbiol. App. Sci. 2017; 6(12):381-395.
7. Salim M, Hossain S, Alam S, Rashid JA, Islam S. Estimation of genetic divergence in Lablab bean (*Lablab purpureus* L.) genotypes. Bangladesh J Agril. Res. 2013b; 38(1):105-114.
8. Sarkar M, Kundagrami S. Multivariate analysis in some genotypes of mungbean (*Vigna radiata* L.) on the basis of agronomic traits of two consecutive growing cycles. Legume Res. 2016; 39(4):523-527.
9. Singh NP, Hardwaj AK, Kumar A. Modern Technology on Vegetable Production. International Book Distributing Company Publishers, Lucknow, 2004, 49-50.
10. Thippani S, Eshwari KB, Bhave MHV. Principal component analysis for yield components in greengram accessions (*Vigna radiata* L.). Inter. J Pure App. Biosci. 2017; 5(4):246-253.
11. Tindall HD. Vegetables in the Tropics. AVI Publishing Company, INC West Port, Connecticut, 1983, 302-303.
12. Yadav RK, Yadav DS, Rai N, Patel KK. Prospects of horticulture in North Eastern region. ENVIS Bull Himal Ecol. 2003; 11(2):10-25.