Vegetable Science (2017) 44 (2) : 62-65

# Assessment of genetic divergence using Mahanalobis $D^2$ and principal component analysis in dolichos bean (*Lablab purpureus* L.)

**Pradeep Kumar Kujur, Vijay Bahadur, Rajnish Shrivastava and Akash Kumar**

Received: July 2017 / Accepted: November 2017

## Abstract

Studies were carried out to assess the genetic divergence among thirty genotypes of dolichosbean using Mahanalobis $D^2$ and principal component analysis of seventeen quantitative traits. Thirty genotypes of dolichos bean were grouped into six clusters. Maximum nine genotypes were included in cluster I and minimum (1) in cluster VI. Maximum inter cluster distance (92.76) was observed between cluster IV and VI and minimum (53.45) between the cluster III and cluster VI. The genotypes of cluster IV were observed with highest character mean for pod width, pod weight, green pod yield per plant and genotypes of cluster V recorded highest mean for number of pod pickings, 100 seed weight, less YBMV incidence and earliest days to flowering and earliest days for green pod harvest. Principal component analysis showed more than 93 per cent of variability for quantitative character in different genotypes. Days to 50% flowering, pod width, vine length, days to last green pod harvest were observed significant variable components and CG-2, CG-8, CG-14, CG-20, CG-21, VRSEM-186 and Pusa Sem-2 were found with maximum value corresponding to these variables. Selecting genotypes from divergent clusters and utilizing them in hybridization programme is likely to produce desirable recombinants, and may lead to improvement in dolichos bean for yield and its contributing traits.

**Keyword:** Dolichos bean, clusters, genetic divergence, principal component analysis (PCA)

## Introduction

Dolichos bean or Hyacinth bean or Sem (*Lablab purpureus* L.) is an important leguminous vegetable grown throughout the country namely Madhya Pradesh, Maharashtra, Andhra Pradesh, Tamil Nadu, Uttar Pradesh, Chhattisgarh and North Eastern states. The crop has multipurpose uses. The green pods and tender leaves are popular vegetables. The dried seeds are consumed as a split pulse. Great range of variation exists in the plant morphological and yield traits among the cultivars grown all over the country. Despite many good attributes, the crop has remained unexploited owing to low productivity, long duration, photosensitivity and an indeterminate growth habit. The consumer preference also varies with respect to pod size, shape, colour and aroma. The efforts of improving the crop by utilizing indigenous and exotic germplasm have been useful in breaking the yield barriers (Shivashankar et al. 1993) resulting in developing compact plant type with reduced duration and photo-insensitivity.

India is the centre of diversity of dolichos bean and large number of indigenous strain is available in northern India. Although this crop has originated in India but very little work has been done for the genetic improvement of yield and quality. A great range of variation exits for the plant and pod characters amongst the accessions grown all over country. Multivariate analysis such as $D^2$ cluster and principal component analysis have been proved to be useful tools in selecting genotypes for improvement. Mahanalobis $D^2$ analysis has been successfully used in measuring the variability. Principal component analysis is useful device for representing a set of variable by a much smaller set of composite variable that account for much of the variance among the set of original variable. It allows visualization of the differences among the individuals, identification of possible groups and relationships among individual and variables. An understanding of nature and magnitude of variability among the dolichos bean genotypes is a pre-requisite for its improvement. Precise information on the nature and degree of variability helps the plant breeder in choosing the diverse parents for purposeful hybridization. The success of any breeding programme in general and improvement of specific trait through selection in particular, totally depends upon the genetic variability present in the available germplasm of a particular crop

Department of Horticulture, Sam Higginbottom Institute of Agriculture, Technology & Sciences, Allahabad, UP
*Corresponding author, Email: pradeep.kujur94@gmail.com

(Parmar et al. 2013). Since, many of the plant characters are governed by polygene and greatly influenced by environmental conditions. The progress of breeding is, however, conditioned by the magnitude, nature and interrelationship of genotypic and non-genotypic variation. Among the quantitative characters, yield is a complex character, which is dependent on a number of yield contributing characters. Therefore, the present study was carried out the thirty genotypes of dolichos bean to understand the genetic diversity and its genetic improvement by $D^2$ and principal component analysis.

## Materials and Methods

The experiment was carried out at the Horticulture Research Farm, Department of Horticulture, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad during kharif season 2015. The experiment was conducted in Randomized Block Design having thirty genotypes collected from different part of Chhattisgarh in three replications. The allocation of treatments of the individual plots using random number in each replications with spacing 1m×1.5m plant to plant and row to row respectively. Five plants from each replication were taken for recording observation on seventeen quantitative traits viz. days to first flowering, days to 50% flowering, inflorescence length, number of flowers per inflorescence, number of pods per inflorescence, days to first green pod harvest, days to last green pod harvest, number of green pod picking, vine length, pod length, pod width, pod weight, number of seeds per pod, 100 seed weight, green pod yield per plant, green pod yield per plot, green pod yield per hectare.

## Results and Discussion

On the basis of $D^2$ analysis, thirty genotypes were grouped into six clusters. Maximum number of genotypes nine were grouped into cluster I (CG-1, CG25, CG-12, CG-8, CG23, CG-3, CG-18, CG-7, CG-15) followed by cluster V having eight genotypes (CG-10, VRSEM-186, CG-19, CG-28, CG-9, CG-27, CG-16, PUSA SEM- 2), cluster III having seven genotypes (CG-6, CG-13, CG-4, CG-22, CG-24, CG-5, CG-2), cluster II having three genotypes (CG-11, CG-17, CG-26), cluster IV having two genotypes (CG-14, CG-21) and cluster VI having one genotype (CG-20).It is vivid (table 2) that maximum inter cluster distance was observed between cluster IV and VI (92.76), which was followed by cluster II and VI (73.016), cluster II and IV (70.96), cluster V and VI (57.86), I and IV (56.92), cluster I and VI (55.84), cluster III and VI (53.45). Highest intra cluster distance was recorded for cluster V (30.65) followed by cluster IV (21.34), cluster III (18.74), cluster I (17.17) and cluster II (11.48) showed minimum intra cluster distance. The pattern of distribution of dolichos bean genotypes in various cluster expressed of considerable genetic diversity in the material (Upadhyay et al. 2011).

Principal component analysis revealed that six components $PC_1$, $PC_2$, $PC_3$, $PC_4$, $PC_5$ and $PC_6$ with Eigen values 7.42, 3.53, 2.44, 1.8, 1.16 and 0.482 respectively, have accounted for 93.64% of the total variation. The first two principal component analysis $PC_1$ and $PC_2$ with a proportion of 41.23 and 19.63%, respectively contributed more towards total variation. According to

**Table 1:** Thirty Genotypes of Dolichos bean grouped into different clusters

| Cluster | No. of genotypes included | Genotypes |
|---|---|---|
| I | 9 | CG-1, CG-25, CG-12, CG-8, CG-23, CG-3, CG-18, CG-7, CG-15 |
| II | 3 | CG-11, CG-17, CG-26 |
| III | 7 | CG-6, CG-13, CG-4, CG-22, CG-24, CG-5, CG-2 |
| IV | 2 | CG- 14, CG21 |
| V | 8 | CG-10, VRSEM-186, CG-19, CG-28, CG-9, CG-27, CG-16, PUSA SEM-2 |
| VI | 1 | CG-20 |

**Table 2:** Mahalanobis distance of between clusters of dolichos bean genotypes

| Cluster | I | II | III | IV | V | VI |
|---|---|---|---|---|---|---|
| I | 17.174 | 29.086 | 27.99 | 56.928 | 41.564 | 55.849 |
| II | | 11.482 | 32.828 | 70.968 | 42.563 | 73.016 |
| III | | | 18.74 | 40.202 | 36.177 | 53.45 |
| IV | | | | 21.347 | 43.65 | 92.769 |
| V | | | | | 30.655 | 57.867 |
| VI | | | | | | 0 |

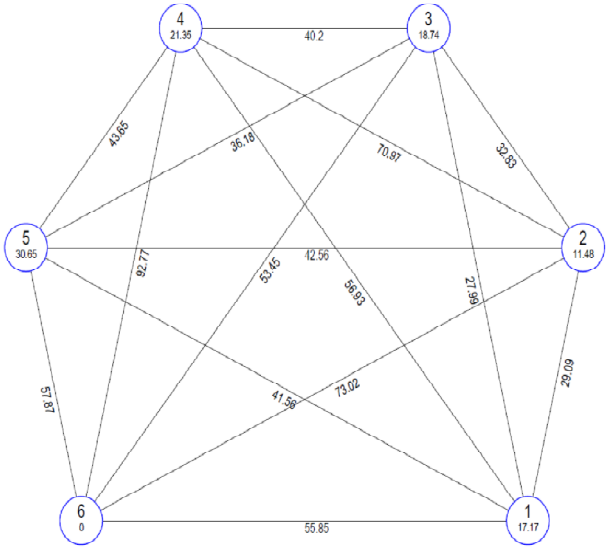


**Fig.1:** Average intra-cluster and inter cluster distance ($D^2$ values) among the 6 cluster in dolichos bean

Chahal and Gosal (2002), characters with the largest absolute values closer to unity with in the first principal component influence the clustering more than those with lower absolute values closer to zero. Therefore, in this study, differentiation of the genotypes into different cluster was because of a cumulative effect of a number of characters rather than the contribution of few characters. Characters having relatively higher value in the first principal component ($PC_1$) were days to first flowering, days to 50% flowering, days to first green pod harvest, no. of green pod pickings, pod yield per hectare and YBMV incidence had more contribution to

**Table 3:** Principal components analysis traits of dolichos bean genotypes

| Traits | PC-1 | PC-2 | PC-3 | PC-4 | PC-5 | PC-6 |
|---|---|---|---|---|---|---|
| Days to First Flowering | 0.354 | 0.022 | 0.086 | 0.03 | 0.122 | 0.182 |
| Days to 50% Flowering | 0.354 | 0.029 | 0.085 | 0.026 | 0.111 | 0.162 |
| Inflorescence Length | 0.259 | -0.007 | -0.268 | -0.325 | -0.203 | -0.159 |
| No. of Flowers Per Inflorescence | 0.185 | 0.059 | -0.255 | -0.43 | -0.319 | 0.274 |
| No. of pods Per Inflorescence | -0.187 | 0.09 | -0.428 | -0.059 | 0.1 | 0.362 |
| Days to First Green Pod harvest | 0.353 | 0.031 | 0.066 | 0.042 | 0.156 | 0.126 |
| Days to Last Green Pod harvest | 0.021 | 0.196 | -0.052 | 0.509 | -0.564 | 0.003 |
| No. of green Pod Picking | 0.322 | 0.123 | -0.071 | 0.223 | -0.073 | 0.299 |
| Vine Length | 0.052 | 0.118 | -0.527 | -0.092 | -0.183 | -0.457 |
| Pod Length | -0.235 | 0.02 | -0.325 | 0.026 | 0.419 | -0.059 |
| Pod Width | -0.024 | -0.506 | -0.152 | 0.038 | -0.004 | 0.083 |
| Pod Weight | 0.122 | 0.416 | -0.128 | 0.114 | 0.3 | -0.299 |
| No. of Seeds Per Pod | -0.288 | 0.138 | 0.243 | 0.007 | -0.321 | -0.113 |
| 100 Seed Weight | -0.194 | 0.178 | -0.329 | 0.289 | 0.049 | 0.429 |
| YBMV Incidence | 0.298 | -0.161 | -0.16 | 0.231 | -0.144 | -0.108 |
| Green Pod Yield/ Plant | -0.104 | -0.363 | -0.158 | 0.42 | 0.002 | -0.092 |
| Green Pod Yield/ Plot | 0.02 | 0.496 | 0.072 | 0.113 | 0.104 | -0.08 |
| Pod Yield / hectare | 0.301 | -0.184 | -0.084 | 0.211 | 0.191 | -0.268 |
| Eigene Value (Root) | 7.421 | 3.533 | 2.448 | 1.806 | 1.166 | 0.482 |
| Percent variability | 41.230 | 19.630 | 13.599 | 10.033 | 6.477 | 2.676 |
| Cumulative variability | 41.230 | 60.860 | 74.459 | 84.492 | 90.969 | 93.645 |

**Table 4:** Principal components analysis of dolichos bean genotypes

| S.N. | Genotype | PC 1 | PC2 | PC3 | PC4 | PC5 | PC6 |
|---|---|---|---|---|---|---|---|
| 1 | CG 1 | 131.413 | -24.826 | -54.631 | 113.873 | -45.096 | 10.972 |
| 2 | CG 2 | 107.760 | -53.473 | -70.500 | 108.226 | -35.214 | 10.306 |
| 3 | CG 3 | 136.541 | -25.609 | -43.846 | 117.034 | -42.456 | 9.129 |
| 4 | CG 4 | 122.749 | -68.672 | -63.612 | 110.874 | -51.024 | 12.216 |
| 5 | CG 5 | 131.632 | -75.662 | -64.787 | 103.553 | -43.383 | 18.882 |
| 6 | CG 6 | 111.671 | -80.818 | -77.272 | 120.804 | -50.779 | 15.794 |
| 7 | CG 7 | 129.226 | -27.133 | -44.234 | 108.892 | -41.174 | 12.165 |
| 8 | CG 8 | 117.479 | -37.042 | -54.830 | 126.192 | -46.951 | 13.704 |
| 9 | CG 9 | 138.135 | -70.137 | -62.745 | 118.042 | -34.230 | 15.415 |
| 10 | CG 10 | 156.255 | -23.261 | -51.060 | 115.509 | -47.763 | 20.952 |
| 11 | CG 11 | 147.565 | -16.719 | -55.752 | 112.676 | -47.494 | 7.125 |
| 12 | CG 12 | 134.711 | -22.713 | -57.749 | 119.190 | -45.628 | 7.130 |
| 13 | CG 13 | 110.611 | -89.821 | -79.444 | 116.944 | -48.978 | 14.684 |
| 14 | CG 14 | 75.966 | -32.377 | -69.163 | 117.526 | -47.056 | 13.296 |
| 15 | CG 15 | 147.448 | -25.260 | -45.738 | 101.266 | -28.751 | 9.934 |
| 16 | CG 16 | 150.791 | -13.529 | -62.788 | 129.980 | -40.680 | 20.525 |
| 17 | CG 17 | 141.310 | -26.598 | -62.169 | 113.671 | -48.488 | 17.613 |
| 18 | CG 18 | 153.691 | -27.594 | -44.822 | 114.049 | -39.717 | 8.760 |
| 19 | CG 19 | 120.186 | -65.366 | -74.408 | 126.961 | -44.335 | 28.332 |
| 20 | CG 20 | 156.166 | -170.165 | -71.936 | 117.734 | -55.235 | 29.920 |
| 21 | CG 21 | 101.886 | -21.519 | -68.895 | 130.415 | -44.130 | 18.913 |
| 22 | CG 22 | 116.950 | -72.987 | -71.036 | 103.293 | -41.816 | 17.039 |
| 23 | CG 23 | 129.192 | -28.017 | -49.547 | 108.548 | -38.338 | 11.843 |
| 24 | CG 24 | 118.952 | -82.427 | -72.135 | 107.131 | -42.376 | 17.417 |
| 25 | CG 25 | 142.636 | -30.236 | -56.192 | 110.080 | -40.526 | 10.141 |
| 26 | CG 26 | 159.428 | -20.379 | -58.149 | 110.658 | -45.677 | 14.855 |
| 27 | CG 27 | 114.865 | -73.616 | -80.249 | 125.549 | -31.571 | 23.796 |
| 28 | CG 28 | 124.033 | -88.078 | -79.493 | 122.453 | -41.469 | 21.384 |
| 29 | VRSEM-186 | 132.467 | -39.027 | -64.624 | 117.364 | -36.401 | 22.176 |
| 30 | PUSA SEM-2 | 134.447 | -81.882 | -93.454 | 122.630 | -23.151 | 22.221 |

total diversity and they were responsible for the differentiation of the six clusters.

The second principal component, which accounted 19.63% of the total variation contributed from pod width, green pod yield per plot, pod weight, green pod yield per plant. Characters like vine length, number of pods per inflorescence were the character contributed to the third principal component ($PC_3$). Similarly number of flowers per inflorescence was the characters contributed to the fourth principal component ($PC_4$). Days to last green pod harvest, pod length, number of flowers per inflorescence, number of seeds per pod were contributed to fifth principal component ($PC_5$). The sixth principal component ($PC_6$) contributed from 100 seed weight. Genotype CG-2, CG-8, CG-14, CG-20, PUSA SEM-2, VRSEM-186 and CG-21 which may appear to be the most diverse may be useful as source for variable characters in dolichos bean improvement among the genotypes studies been most distance.

## सारांश

सेम के 30 जननद्रव्यों की आनुवंशिक विभिन्नता का आकलन करने के लिए महानालोबिस डी² के उपयोग से अध्ययन किया गया तथा 17 मात्रात्मक चरित्रों के लिए प्रमुख घटकों का विश्लेषण किया गया है। सेम के 30 प्रभेदों के 6 समूह बने। समूह एक में अधिकतम 9 प्रभेदों तथा समूह 6 में सबसे कम एक प्रभेद शामिल हुआ। समूहों के बीच की अधिकतम दूरी (92.76) समूह 4 और 6 के बीच पायी गयी और सबसे कम (53.45) समूह 3 एवं 6 के बीच पायी गयी। समूह 4 के प्रभेदों में फली की चौड़ाई फली भार, प्रति पौधा हरी फलियों का उपज का औसत अधिकतम पाया गया और समूह 5 के प्रभेदों में अधिकतम प्रति तुड़ाई फलों की संख्या 100 बीज भार पीला मोजैक वायरस का कम प्रकोप तथा फूल आने का कम समय और पहली तुड़ाई में लगे कम समय आदि के लिए देखा गया। प्रधान घटक विश्लेषण से स्पष्ट हुआ कि विभिन्न प्रभेदों के मात्रात्मक लक्षणों में 93 प्रतिशत से अधिक विविधता है। सामान्यतः 50 प्रतिशत फूल आने के दिनों की संख्या, फल की चौड़ाई, लता की लम्बाई एवं अंतिम हरी फली के तुड़ाई के दिनों में सार्थक विविधता देखी गयी तथा प्रभेदों में सी जी–2, सी जी–8,सी जी–14, सी जी–20, सी जी–21, वी आर सेम 186 और पूसा सेम–2 में विविधताओं के लिए अधिकतम मान देखे गये। विभिन्न समूहों के प्रभेदों को चयन कर संकरण कार्यक्रम में प्रयोग किया जा सकता है जिससे ऐच्छिक संयोज उत्पन हो सकते हैं एवं सेम के उपज और उपज संबंधित घटकों के सुधार में प्रयोग किया जा सकता है।

## References

Chahal GS and Gosal SS (2002) Principal and procedures of plant breeding. In: Biotechnology and conventional Approaches. Narosa Publishing House, New Delhi, pp 336.

Chattopadyay A and Dutta S (2010) Characterization and identification of selection indices of pole type dolichos bean. Veg Crops Res Bull 73: 33-45.

Lal H, Rai M, Verma A and Vishwanathm (2005) Analysis of genetic divergence of dolichos bean (*Lablab purpureus*) genotypes. Veg Sci 32 (2): 129-132.

Shivashankar G, Kulkarni RS, Shashidhar HE and Mahishi DM (1993) Improvement of field bean. Advan Hort 5: 277-286.

Nahar K and Newaz MA (2005) Genetic variability, character association and path analysis in lablab bean (*Lablab purpureus* L.). Int J Sust Agri Technol 6 (1): 35-40.

Parmar M, Singh AP, Dhillon, NPS and Jamwal M (2013) Genetic variability of morphological and yield traits in Dolichos bean (*Lablab purpureus* L.). African J Agric Res 8(12): 1022-1027.

Rai N, Singh PK, Verma A, Lal H, Yadav DS and Rai M (2008) Multivariate characterization of Indian bean (*Lablab purpureus* L.) genotypes. J Plant Genet Res 21(1):42-45.

Singh S, Singh PK, Singh DR, Pandey VB and Srivastava RC (2015) Genetic variability and character association study in dolichos bean (*Lablab purpureus* L.). Indian J Hort 72(3): 343-346.

Upadhyay D and Mehta N (2010) Biometrical studies in dolichos bean (*Dolichos lablab* L.) for Chattisgarh Plains. Res J Agril Sci 1(4): 441-447.

Upadhyay D, Mehta N, Singh J and Sahu M (2011) Genetic diversity in dolichos bean (*Dolichos lablab* L.). Legume Res 34(2): 146-148.

Verma AK, Jyothi KU and Rao AVD (2014) Genetic variability, heritability and genetic advance studies in Dolichos bean (*Lablab purpureus* L.) genotypes. Electronic J Plant Breeding 5(2): 272-276.