VARIABILITY, ASSOCIATION AND GENETIC DIVERGENCE ANALYSIS IN DOLICHOS BEAN

(*Lablab purpureus* L.)

M. Sc. (Ag.) THESIS

by

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THESIS

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CERTIFICATE – I

This is to certify that the thesis entitled **"VARIABILITY, ASSOCIATION AND GENETIC DIVERGENCE ANALYSIS IN DOLICHOS BEAN (*Lablab purpureus* L.)"** submitted in partial fulfilment of the requirements for the degree of **"Master of Science in Agriculture"** of the Indira Gandhi Krishi Vishwavidyalaya, Raipur, is a record of the bonafide research work carried out by **KU. SAVITA PATEL** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma (certificate awarded etc.) or has been published/published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by her.

Date 22/7/14

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Member Dr. Dhananjay Sharma _____ 22/07/14

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Member Dr. Ravi R. Saxena _____

CERTIFICATE – II

This is to certify that the thesis entitled **"VARIABILITY, ASSOCIATION AND GENETIC DIVERGENCE ANALYSIS IN DOLICHOS BEAN (*Lablab purpureus* L.)"** submitted by **KU. SAVITA PATEL** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur in partial fulfilment of the requirement for the degree of **"Master of Science in Agriculture"** in the **DEPARTMENT OF HORTICULTURE** has been approved by the external examiner and Student's Advisory Committee after an oral examination.

Date: 1/9/2014

EXTERNAL EXAMINE

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LIST OF ABBREVIATION

Abbreviation	Description
@	At the rate
%	Per cent
^{o}C	Degree celsius
CD	Critical difference
Cm	Centimetre
Df	Degree of freedom
et al.	And co-workers/ and others
Fig.	Figure
G	Gram
GCV	Genotypic coefficient of variation
Ha	Hectare
i.e.	That is
No.	Number
PCV	Phenotypic coefficient of variation
pH	Logarithm of the reciprocal of the H^{+} ion activity
Q	Quintal
viz.	Namely
Kg	Kilogram

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Introduction

CHAPTER- I

INTRODUCTION

Dolichos bean (*Lablab purpureus* L.*)* is an important leguminous vegetable crop grown throughout the country and distributed in Madhya Pradesh, Maharastra, Andhra Pradesh, Tamil Nadu and North Eastern states. It is commonly called as Hyacinth bean, bonavist bean, Indian bean, field bean, Egyptian bean, Avare in Kannada. It belongs to the family Fabaceae. The name "Lablab" is an Arabic or Egyptian name describing the dull rattle of the seeds inside the dry-pod.

It is potentially a herbaceous perennial but cultivated as an annual with bushy, erect or climbing races. Sem is primarily grown for green pods and is rich in protein (3.8%, green pod basis). The dry seeds are also used for various vegetable preparations and foliage of the crop provides hay, silage and green manures (Bose *et al*., 1993). It is sensitive to photoperiods and both short day and long day types are available and recently some day neutral types are also reported. Field bean is a drought tolerant crop and it is an excellent crop to be grown in dry lands with limited rainfall. It can not stand waterlogging condition.

Vavilov (1939) had considered India as the primary centers of origin of dolichos bean and wild forms are found in many parts of the country. Although this crop has originated in India but very little work has been done for the genetic improvement in yield and quality. A great range of variation exists for the plant and pod characters amongst the accessions grown all over the country.

In India two botanical varieties are recognized. They are *Dolichos lablab* var. *typicus* Prain which is commonly called as Lablab bean treated as a perennial twining herb, cultivated mostly as an annual and *Dolichos lablab* var. *lignosus* (L.) Prain,

commonly known as Australian pea, it is a semi-erect, bushy, perennial herb (Purseglove, 1968). During 1970, Verdcourt has recognized three sub-species: (a) *unicinatus* (b) *purpureus* and (c) *bengalensis*. Species *unicinatus* was the ancestral form distributed mainly in East–Africa with small pods, species *purpureus* with large pods and species *bengalensis* had linear oblong shaped pods and found widely spread in Asia.

Chhattisgarh state has wide genetic variability for various traits like plant habit, branching habit, stem pigmentation, leaf veination, flower colour, pod colour, pod characters, *viz.*, shape, size, weight and seeds per pod etc. In dolichos bean genetic variability studies of yield components indicated the existence of wide genetic base among the various genotypes. Moreover high heritability coupled with high genetic gain for most of the characters showed the presence of appropriate genetic background for further selection with a view to improve yield and some of its component characters (Patel, 2010).

The characters for which variability is present should be highly heritable for the success of crop improvement programme as progress due to selection depends on heritability, selection intensity and genetic advance of the character. Heritability and genetic advance estimates for different targeted traits help the breeder to apply appropriate breeding methodology in the crop improvement programme.

The genetic variability in Chhattisgarh provides a better opportunity for crop improvement work. The crop shows a high potential both as a field grown pulse and as a vegetable for home gardens.

Hitherto, very little attention is given by the workers on systematic crop improvement work of dolichos bean. Hence, under the present investigation a systematic breeding programme has been initiated for exploiting the available genetic

wealth for development of consumer acceptable variety at national level as well as in Chhattisgarh region.

In view of above facts this investigation entitled **"VARIABILITY, ASSOCIATION AND GENETIC DIVERGENCE ANALYSIS IN DOLICHOS BEAN (*Lablab purpureus* L.)"** will be cunduct with following objectives:

1. To find high yielding and better genotypes of dolichos bean suitable for Chhattisgarh plains.
2. To study the genetic variability for green pod yield and their component characters in dolichos bean.
3. To find out genetic divergence in collected Chhattisgarh germplasm lines.

To work out heritability, genetic advance, correlation and path coefficient analysis of green pod yield and its component characters in dolichos bean.

Review of Literature

CHAPTER- II

REVIEW OF LITERATURE

A sincere effort has been made to collect the available literature on the topic **"Variability, association and genetic divergence analysis in Dolichos bean" (*Lablab purpureus* L.)**" and has been reviewed in this chapter under the following heads:

2.1 Genetic variability

2.2 Heritability and genetic advance

2.3 Correlation coefficient studies

2.4 Path coefficient analysis

2.5 Genetic divergence

2.1 Genetic variability

The genetic improvement in any crop plants primarily depends on the magnitude of available genetic variability. The phenotypic variability expressed by a genotype or a group of genotypes in any species can be partitioned into genotypic and phenotypic components. The genotypic component being the heritable part of the total variability, its magnitude on yield and its component characters influences the selection strategies to be adopted by the breeders.

There are two kinds of variability in crop plants, genetic and non genetic. The study of genetic variability was made for the first time by the great biologist, Fisher (1918) and subsequently the estimates of genotypic and phenotypic variations were used to predict the expected genetic response.

Very little attention is given by the scientists on systematic crop improvement work of Dolichos bean. Therefore very little information is available on the topic under "**Variability, association and genetic divergence analysis in Dolichos bean (*Lablab purpureus* L.)**" hence, information related to genetic improvement of other leguminous crops are also gathered and reviewed under following sub heads.

Pandita *et al.* (1980) at Hissar, Haryana, studied the genetic variability in twenty six varieties of *Dolichos lablab*. A wide range of variability was observed in most of the characters. The coefficient of genetic variation was highest for number of flowers per plant and green pod yield per plant (kg).

Rao (1981) studied nine genotypes of field bean and estimated a large genotypic coefficient of variation for the characters pod yield per plant, pods per plant, seed yield per plant, inflorescence length, pods per inflorescence and plant height.

Wahabuddin and Bhalla (1986) studied six polygenic mutant of *Dolichos lablab* var. *lignosus* and reported that, in the M_3 most of the mutant showed high degree of genotypic variation.

Dahiya and Pandita (1989) at Hissar, Haryana, worked on 34 lines of *Dolichos lablab* L. The two genotypes HD247 and HD257 were superior to all others for pod yield/plant and number of pods /plant. High values for heritability and genetic advance for five characters suggested that selection for improved yield would be effective.

Borah and Shadeque (1992) at Jorhat, Assam, evaluated twelve cultivars of *Dolichs lablab* for twenty yield and quality characters and observed significant genetic variation for most of the characters.

Desai *et al.* (1996) at Navsari, Gujrat, worked on six varieties of Indian bean and reported significant differences for most of the characters.

Uddin and Newaz (1997) at Mymensingh, Bangladesh, evaluated fifteen hyacinth bean genotypes including 13 local genotypes collected from different regions of Bangladesh and two exotic genotypes of Japanese origin for eight flower and pod characters. Highly significant differences were observed among the genotypes for all the eight characters studied. Highest genetic variability was found for green pod yield and green pods per plant, whereas rate of flower abortion exhibited the lowest genotypic coefficient of variability.

Saud and Bhorali (1998) evaluated seventeen indigenous cultivars of *Dolichos lablab* for different quantitative and qualitative characters. Five cultivars were high yielding. The cultivars were grouped into four broad groups according to seed pigmentation patterns. Two cultivars, Sylheti Uri and Aswina Uri, showed better field resistance to biotic stresses than the other cultivars. The wide variability observed for all traits among the cultivars which could be utilized in breeding programmes, and Sylheti Uri and Aswina Uri particularly recommended for breeding for earliness.

Vidya *et al.* (2002) obtained wide range of variability for number of pods per plants, green pod yield per plant and pod characters indicating diversity among yard-long bean cultivars. Yield of vegetable pods per plant recorded highest genotypic and phenotypic coefficient of variation followed by number of pods per plants and pod weight.

Narayanan Kutty *et al*. (2003) evaluated sixty-three accessions of vegetable cowpea for twelve quantitative characters including yield in a field experiment conducted in Kerala, India. High variability was observed for green pod yield, pod

weight, number of pods per plant, pod length, number of pickings and 100-seed weight.

Venkatesan *et al.* (2003) reported in cowpea that relative magnitude of phenotypic coefficient of variation is greater than corresponding genotypic coefficient of variation which indicates the effects of environment. The magnitude of phenotypic coefficient of variation and genotypic coefficient of variation was high for plant height and dry matter production.

Singh *et al.* (2004) at Usman, Haryana, conducted a study from 1995 to 1998 to screen different genotypes of Dolichos bean [*Lablab purpureus*] in rainfed condition of Bullowal Saunkari, Punjab, India, to isolate the appropriate germplansm of immediate adoption and further use in the genetic improvement of this crop for dry land condition. Fifteen genotypes of Dolichos bean were evaluated and highly significant genotypic coefficient of variation had been observed for days to flower initiation, pod length, pod width and green pod yield per plant. The year effect was also highly significant for green pod yield per plant.

Resmi *et al.* (2004) obtained considerable genetic variability among thirty genotypes for yield and its contributing traits of cowpea. High phenotypic coefficient of variance and genotypic coefficient of variance were recorded for pod yield per plant, pods per kg, number of inflorescence per plant and pod weight.

Bendale *et al.* (2008) at Ratnagiri, Maharastra, worked out eight lablab bean parents and their 20 selected progenies of crosses in F_3 generation. The studies revealed that seed yield per plant had highly significant positive association with plant height, primary branches per plant number of leaves per plant, leaf area per plant, days to flower appearance and overall maturity at phenotypic level.

Upadhyay (2008) at Raipur, Chhattisgarh, studied the analysis of variance of 32 genotypes of Dolichos bean and recorded that mean sum of squares due to genotypes were significant for all the characters. Estimates of genetic parameters for various characters revealed that relative magnitude of phenotypic coefficient of variation was higher than the genotypic coefficient of variation**.** The mean performance for marketable green pod yield and pod length of IS-2 was superior amongst all the genotypes and marketable pod weight as well as number of seeds per pod was highest in IS-17. The entry IS-8 was recorded maximum number of pods per inflorescence. National check Swarna Utkrishti showed highest seed index amongst all genotypes**.**

Mohan *et al*. (2009) at IIHR, Bangalore evaluated 57 pole type vegetable Dolichos bean (*Lablab purpureus* var *typicus*) collected from T.N., Karnataka and Pondicherry, for pod yield and pod related trait during 2006-2008 and recorded significant differences for all traits studied. The present study indicates existence of a wide range of variability for pod characters, namely, pod-maturity, pod-length, ten pod weight, number of pods per plant and pod-colour. High yielding lines with different pod types can serve as potentially useful parents in further breeding.

Islam *et al*. (2011) studied forty four hyacinth bean genotypes to estimate the variability, heritability, genetic advance and correlation coefficients. There was a large variation among the genotypes for all the characters among which the number of pods per plant had highest (122 to 425). Green pod yield per plant varied from 0.46 kg to 3.45 kg indicating the presence of high yielding genotypes. High genotypic coefficient of variation was obtained for 100 green seed weight, pod yield per plant, number of pods per plant and harvesting duration.

2.2 Heritability and genetic advance

The term heritability in broad sense can be defined as the ratio of genetic variance to the total phenotypic variance (Lush, 1940). It is generally expressed in percentage. Thus the heritability is the heritable portion of phenotypic variance which is good index of the transmission of characters from parents to their offspring (Falconer, 1960).

Depending upon the components of variance used as numerator in the calculation, heritability is of two type's *viz.* broad sense heritability and narrow sense heritability.

Heritability estimate provides the information regarding the amount of transmissible genetic variation to total variation and determines genetic improvement and response to selection.

Johnson *et al*. (1955) emphasized that heritability estimates, when studied in conjunction with genetic advance would provide more appropriate information than the study of heritability alone.

Improvement in the mean genotypic value of selected plants over the parental population is known as genetic advance. The estimate of genetic advance in percentage of mean provides more reliable information regarding the effectiveness of selection in improving a trait. It is the measure of genetic gain under selection. The success of genetic advance under selection depends on three main factors *viz.* genetic variability, heritability, selection intensity (Allard, 1960).

Estimates of genetic advance help in understanding the type of gene action involved in the expression of various polygenic characters. High values of genetic advance are indicative of additive gene action and low values are indicative of non-additive gene action. Thus, the estimates of heritability and genetic advance are of great significance to the plant breeders for developing suitable selection strategy.

Heritability and genetic advance are important selection parameters. Heritability estimates along with genetic advance are normally more helpful in predicting the gain under selection than heritability estimates alone. However, it is not necessary that a character Although, very scanty information is available on this crop.

Literature available on heritability and genetic advance on Dolichos bean and related crops are reviewed here:

Pandita *et al.* (1980) at Hissar, Haryana, studied twenty six varieties of *Dolichos lablab* and estimated high heritability for number of flowers per cluster, pod size and green pod yield.

Rao (1981) at Anantpur, A.P. studied nine genotypes of field bean and estimated high heritability (broad sense) and genetic advance was also observed for pod yield, seed yield and pods per plant.

Wahabuddin and Bhalla (1986) worked with six polygenic mutant forms of *Dolichos lablab*, and reported that, most of the mutants showed high heritability and genetic advance for green pod yield related traits, fertile branches per plant, pods per plant and 100 seed weight and suggested that the traits having high heritability coupled with high value of genetic advance should be used as selection criteria for improvement of sem.

Borah and Shadeque (1992) worked in twelve cultivars of dolichos bean [*Lablab purpureus* L.] collected from different areas of Assam and observed high heritability in most of the yield contributing characters.

Desai *et al.* (1996) at Navasari, Gujarat, studied the heritability and genetic advance in dolichos bean. This study revealed that there is ample scope for improvement of number of branches per plant, seeds per pod, clusters per pods,

number of pods per plant, days to flowering, days to maturity, 100 seed weight and green pod yield per plant.

Vidya *et al.* (2002) evaluated fifty genotypes of vegetable cowpea and observed high heritability in broad sense and genetic advance for yield of vegetable pods per plant, number of pods per plant, pod weight and pod length.

Pal *et al.* (2003) observed high genetic advance for plant height, peduncle length, number of primary branches per plant, number of peduncles per plant and green pod per plant in cowpea.

Venkatesan *et al.* (2003) reported high heritability coupled with high genetic advance for plant height, dry matter production, pods per plant and seed yield per plant indicating the importance of additive gene effects and pod length also exhibited high heritability for cowpea.

Singh *et al.* (2004) evaluated fifteen genotypes of dolichos bean and observed high heritability for days to flower initiation, pod length, pod width and green pod yield per plant.

Tukadia *et al.* (2006) reported moderate heritability of pod length and days to flowering while it was low for pod width seeds per pod and green pod yield per plant.

2.3 Correlation coefficient studies

Correlation coefficient is a statistical measure which is used to find out the degree and direction of relationship between two or more variables.

The original concept of correlation was represented by Galton (1888) and he suggested the need of coefficient of correlation to describe the degree of association between variables. Later the theory of correlation was developed by Pearson (1904). Thereafter, Searle (1961) described the mathematical implications of correlation coefficient at phenotypic, genotypic and environmental level.

Pandey *et al.* (1980) worked out correlation analysis in thirty six varieties of *Dolichos lablab.* The green pod yield was highly correlated with leaflet area, number of days to flowering, 100 seed weight, pod width and protein content.

Pandita *et al.* (1980) at Hissar, Haryana, worked on twenty six varieties of dolichos bean and reported that length of inflorescence and pod length were highly and positively correlated with yield whereas days to flowering was negatively correlated with yield.

Singh and Chaudhary (1985) worked on 18 varieties of sem and reported that highly significant and positive correlations for days to first flowering with days to first picking, number of flowers per cluster with number of pods per cluster, 100-seed weight with pod width. Significant and positive correlation was also found between number of pods and pod length.

Dahiya *et al.* (1991) at Hissar, Haryana, worked out correlation coefficients using thirty six genotypes of sem *(Labalb purpureus).* Their study revealed that all eight yield contributing characters *viz*. number of pods per plant, weight of pod, pod length, pod width, days to flower, branches per plant, vine length and green pod yield per plant except pod length exhibited high degree of correlation with green pod yield at both the phenotypic and genotypic level.

Desai *et al.* (1996) evaluated six varieties of dolichos bean and reported that branches per plant, cluster per plant, 100 seed weight, pods per plant and seeds per pod were main yield contributing charecters.

Uddin and Newaz (1997) evaluated fifteen hyacinth bean genotypes (including 13 local genotypes collected from different regions of Bangladesh and two exotic genotypes of Japanese origin) for eight flower and pod characters. This trial was conducted at Mymensingh, Bangladesh, and they reported that Correlation

studies showed significant positive associations of number of flowers per inflorescence with rate of flower abortion, number of pods per inflorescence, number of green pods and inflorescences per plant. Green pod yield had strong significant positive association with pod number, inflorescences per plant and pod weight.

Yadav *et al.* (2003) reported positive and significant association of green pod yield per plant with plant height, pods per cluster, pod length, pods per plant, seeds per pod and pod dry matter in cowpea.

Nigude *et al.* (2004) proved that green pod yield per plant was significantly and positively associated with all the characters except pod length and test weight at both levels in cowpea.

Lovely and Radhadevi (2006) carried association studies in fifty genotypes of yard-long bean and observed that pod yield per plant had strong positive correlation with pods per cluster, pods per plant, pod weight, pod length, pod breadth and seeds per pod.

Bendale *et al*. (2008) at Ratnagiri, Maharashtra, worked out eight lablab bean parents and their 20 selected progenies of crosses in F3 generation. The studies revealed that seed yield per plant had highly significant positive association with plant height, primary branches per plant number of leaves per plant, leaf area per plant, days to flower appearance and overall maturity at phenotypic level.

2.4 Path coefficient analysis

Path coefficient analysis is carried out using the estimates of correlation coefficient. The concept of path coefficient analysis was originally developed by Wright in 1921, but the technique was first used for plant selection by Dewey and Lu (1959). Path coefficient analysis is simply a standardized partial regression coefficient which splits the correlation coefficient into the measures of direct and

indirect effects. In other hands, it measures the direct and indirect contribution of various independent characters on a dependent character.

Path coefficient analysis is used as effective tool in finding out the direct and indirect attributes of different contributing characters towards yield. Each component possesses a large direct effect on yield and its important indirect effect result via different yield components.

Baswana *et al.* (1980) at Hissar, Haryana, revealed that plant height, number of pod per plant and pod weight showed direct and positive effect for increasing the green pod yields in dolichos bean.

Pandey *et al*. (1980) at Hissar, Haryana, carried out path analysis of *Dolichos lablab* and revealed that leaflet area, number of days to flowering, hundred seed weight, pod width and protein content shows positive effect for improvement of green pod yield.

Rao (1981) at Anantapur, A.P., carried out path analysis of nine field bean genotypes and revealed that pods per plant showed highest direct effect on seed yield per plant at both genotypic and phenotypic levels.

Dahiya *et al.* (1991) at Hissar, Haryana, worked on dolichos bean and revealed that selection based on number of pods per plant, plant height and pod weight will be more effective for the improvement of yield.

Desai *et al*. (1996) at Navasari, Gujarat, evaluated six varieties of dolichos bean and reported that number of seeds per pod, number of clusters per plant, hundred seed weight were main yield contributing characters.

Subbaiah *et al.* (2003) observed that the number of pods per plant had strong positive direct effect as well as indirect effects through various traits on green pod

yield. The other traits namely number of branches per plant; pod length, pod weight, and number of seeds per pod also had strong positive influence on green pod yield.

Venkatesan *et al.* (2003) evaluated twenty genotypes of diverse origin and their path analysis showed positive direct effect on number of pods per plant, pod length, clusters per plant, seeds per pod, and hundred seed weight on yield of cowpea.

Yadav *et al.* (2003) recorded dry matter in pod, pods per plant, seeds per pod and plant height are main components of green pod yield per plant in path analysis studies in cowpea.

Lovely and Radhadevi (2006) carried association studies in fifty genotypes of yard-long bean and the maximum positive direct effect on pod yield was observed for pods per plant followed by pod weight, pods per cluster, pod length, seeds per pod, main stem length and pod breadth.

Bendale *et al.* (2008) at Ratnagiri, Maharastra, worked out eight lablab bean parents and their 20 selected progenies of crosses in F_3 generation. The path coefficient analysis revealed that among the developmental characters *viz*. plant height, primary branches per plant, number of leaves per plant, leaf area per plant, days to flower appearance and first pod maturity had direct effect on seed yield per plant at phenotypic level while the characters plant height, primary branches per plant, days to flower appearance and first pod maturity had direct effect on seed yield per plant at genotypic level.

2.5 Genetic divergence

The assessment of genetic diversity using quantitative traits has been of prime importance in many contexts particularly in differentiating well defined populations. The concept of D^2 statistics was originally developed by P.C. Mahalonobis (1936). Then C.R. Rao (1952) suggested the application of this technique for the arrangement

of genetic diversity in plant breeding. This method is widely used in self and often cross pollinated crops to establish relationship between genetic divergence of parental types and other populations. Now, this technique is extensively used in vegetable breeding for the study of genetic divergence in the various breeding material including germplasm. This analysis also helps in the selection of diverse parents for the development of hybrids.

Nandi *et al.* (2000) at Keonjhar, Ordisha, studied the genetic divergence for twenty eight genotypes of Indian bean for eight characters as measured by Mahalanobis's D^2 analysis. These genotypes were grouped into five clusters. Cluster I was the largest containing twenty two genotypes followed by Cluster III with three genotypes. Remaining three Clusters (II, IV and V) had a single genotype each. The members of the I Cluster had originated from different geographic regions and genetic divergence did not follow the same trend. The intra and inter-cluster average D^2 values indicated that the geographical distributions could not be related to spatial patterns of the Clusters. Clusters II and V showed maximum divergence followed by Clusters I and V and clusters I and IV. Minimum divergence was observed between Clusters II and III followed by Clusters II and IV. Cluster I had higher intra–cluster D^2 value followed by Cluster III. However, Clusters II, IV and V had no cluster distance as they were represented by a single genotype each.

Narayanan Kutty *et al.* (2003) at KAU conducted genetic variability and divergence studies on thirty-seven genotypes of vegetable cowpea, which revealed significant differences for all the twelve characters studied. High phenotypic coefficient of variation and genotypic coefficient of variation were noticed for fruit yield, pods per plant and weight of pod. High heritability coupled with high genetic advance was also observed for the above characters, indicating additive gene action

and emphasized the effectiveness of selection for the improvement of these traits. The 37 genotypes were grouped into eleven clusters using Mahalanobis D^2 statistics. In general, the intercluster distances were higher than intracluster distances. The maximum intercluster distance was between clusters VIII and X, followed by clusters VI and X and clusters VIII and IX, respectively. The intracluster distance was maximum in cluster VII.

Vineeta *et al.* (2004) grouped fifty genotypes of cowpea into four clusters on the basis of D^2 values. Maximum numbers of genotypes (forty five) were included in cluster I, while cluster II and III had two genotypes each, and cluster IV had only one genotype. The cluster pattern of genotypes revealed that the genetic diversity was not always related with geographical diversity. Genotypes in cluster IV recorded high mean values for number of clusters, number of pods, 100-seed weight, seed yield per plant, dry weight per seedling, vigour index and *in-vitro* protein digestibility, with low values for pod length and tannin content. Genotypes in cluster I showed maximum mean values for standard germination and shoot length. Divergent parents from cluster I, cluster III and cluster IV may be used in hybridization programmes to get transgressive segregants for high seed yield and quality traits in cowpea.

Golani *et al*. (2007) conducted an experiment at Junagadh, Gujarat, using Mahalanobis's D^2 statistics to analyse the genetic diversity in eighteen accession of Indian bean (*Lablab purpureus* L.) for yield and its contributing characters and reported that significant variation for all the traits. They also recorded moderate value of GCV along with high heritability and genetic advance for pod width, 10 pod weight, plant spread and pod length. Pod width had positive and strong correlation with yield, while days to first picking had negative and strong association with yield. The genotypes were grouped into eight clusters. Among the eight clusters, cluster I

had maximum number of genotypes (seven), cluster II to cluster V each had two genotypes, while cluster VI to VIII were solitary with only one genotype in each cluster. The maximum genetic distance was observed between cluster III and cluster V followed by cluster V and cluster VII. Cluster I and cluster VII exhibited lowest degree of divergence. The maximum intra cluster distance was exhibited by cluster IV followed by cluster V. The mean value for most of the traits was highest in cluster VIII. Pod width followed by number of branches per plant, plant spread, number of seeds per pod contributed higher towards total divergence.

Patel (2010) at Raipur, Chhattisgarh, worked out genetic divergence of 63 genotype of Dolichos bean and reported that genotypic differences were significant for all the characters. The magnitude of phenotypic coefficient of variation was higher than the corresponding genotypic coefficient of variation for most of the characters. The mean performance for marketable green pod yield per plant, pod length and inflorescence length of IS-02 was superior among all the genotypes. Number of flower per inflorescence was maximum in IS-38, as well as number of pod per inflorescence was maximum in IS-08. Likewise hundred seed weight was maximum in IS-04. The entry IS-37 was recorded largest pod width whereas national check Swarna Utkrishti showed optimum seed index among all the genotypes. Sixty three genotypes were grouped into six clusters. The intra and inter cluster distance were computed for all the clusters. The result indicated that the genotypes belongs the cluster II *viz.* IS-02, IS-04, IS-28 and IS-38 may be utilized as parents for hybridization in future breeding programmes.

Rap *et al.* (2010) analysed genetic divergence in 48 Dolichos bean genotypes during 2006-07 and 2007-08, using the Mahalanobis distance statistics. Genotypes were grouped into 9 clusters, with a minimum number of one genotype per cluster.

There was a lack of relationship between genetic and geographic diversity. Maximum intra cluster distance was recorded in cluster IV, whereas maximum inter cluster distance was found between clusters VII and VIII, followed by clusters II and VII. Genotypes cluster IX had the highest green pod yield/plant.

Pawar *et al.* (2013) at MPKV, Rahuri evaluated fifty eight diverse genotypes of lablab bean *(Lablab purpureus* L. Sweet) for their genetic divergence for grain yield and yield contributing characters. The genotypes were grouped into seven clusters on the basis of relative magnitude of D^2 values. The maximum genetic distance was observed between cluster IV and cluster VII (45.798) followed by cluster IV and cluster VI (42.723) and cluster III and cluster VII (40.680). Cluster II and cluster III displayed lowest degree of divergence. The maximum intra cluster distance was exhibited by cluster I (22.432) followed by cluster VI (17.807) and cluster V (16.872), whereas minimum was recorded by cluster III. The maximum mean value for grain yield per plant was recorded in cluster III due to maximum number of inflorescences per plant. Protein content followed by days to 50% flowering and days to maturity contributed maximum towards total divergence.

Materials and Methods

CHAPTER- III

MATERIALS AND METHODS

This chapter deals with a concise description of the materials used and methods adopted in carrying out the present investigation entitled **"Variability, association and genetic divergence analysis in Dolichos bean (*Lablab purpureus* L.)"** The investigation was conducted in *Kharif* to *Rabi* season during the year 2013-14 under All India Coordinated Research Project on Vegetable Crops at Horticultural Research cum Instructional Farm of Department of Horticulture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.).

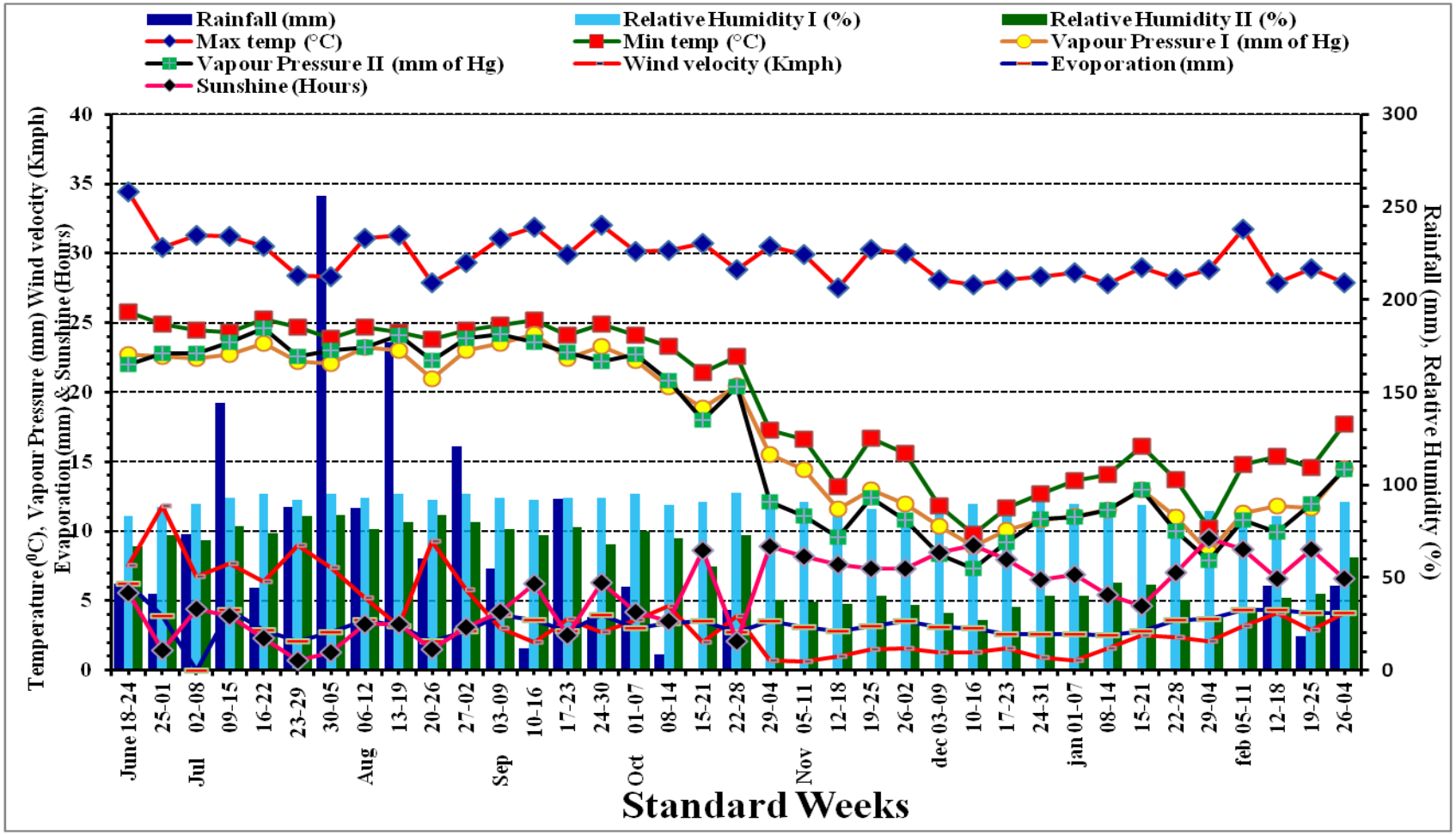
3.1 Geographical Situation

Raipur is situated in mid eastern part of Chhattisgarh at latitude 21^{o}16'N, longitude 81^{o}36'E and at an altitude of 289.56 meters above the mean sea level.

3.2 Agro-climatic condition

The weather data recorded during the period of investigation from sowing to harvesting are presented in Fig 3.1. The general climate prevailing in the district Raipur capital of Chhattisgarh region is dry sub-humid type with annual rainfall varying from 1200 to 1400 mm which is mostly received from the middle of June to end of September, with occasional light showers during winter and summer season. The temperature reaches upto maximum of 46^{o}C during summer and minimum temperature during winter may go down to 8^{o}C in Raipur. According to meteorological observation during the crop season of this investigation February is the hottest and December is the coolest month.

Weekly average meteorological data during the span of experimentation, as recorded at Meteorological Observatory, IGKV, Raipur are presented in Appendix-I



Weekly meteorological data during the crop growth period

(July 24th 2013 to February 17th 2014)

3.3 Soil of the experimental field

The soil of the experimental field was sandy loam in texture which is locally known as "*Matasi*" and is neutral in reaction with the pH 7.5.

3.4 Field preparation

The preparation of field was done by tractor-drawn cultivator followed by two cross-harrowing to pulverize the soil. To enrich the soil, well-rotten FYM @ 15 t/ha was applied after harrowing and well-mixed with the soil by planking. Finally, the field was levelled with planker and then experiment as per experimental design was laid out in recommended plot size of field *i.e.* 3.6x3 m^2.

3.5 Details of treatments

The experimental material consists of hundred genotypes of Lablab bean, which was laid out in randomized block design with three replications. Details of genotypes are presented in table 3.1.

3.6 Experimental material

Hundred genotypes of dolichos bean were grown in a randomized block design with three replications. The sowing of experimental material was done on 24/07/2013 during the year 2013-2014. The seeds were sown in lines 60 cm apart @ 30 Kg seeds per ha. A gap of 30 cm was kept in between two genotypes sown in the bed. Number of plants per plot was 60. Recommended dose of fertilizers *i.e.* 40:60:80 $N:P_2O_5:K_2O$ kg/ha and other cultural package of practices along with bamboo staking were adopted for better crop growth. Five competitive plants were selected at randomly tagged from each plot to record observation on various characters. The average value of each character was calculated on the basis of five plants for each genotype in every replication.

Table 3.1 Details of the genotypes / varieties

S.No.	Treatments/ Genotypes	Source
1	IS-1	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
2	IS-2	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
3	IS-3	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
4	IS-4	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
5	IS-5	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
6	IS-6	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
7	IS-7	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
8	IS-8	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
9	IS-9	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
10	IS-10	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
11	IS-11	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
12	IS-12	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
13	IS-13	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
14	IS-14	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
15	IS-15	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
16	IS-16	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
17	IS-17	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
18	IS-18	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
19	IS-19	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
20	IS-20	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
21	IS-21	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
22	IS-22	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
23	IS-23	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
24	IS-24	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
25	IS-25	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
26	IS-26	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)
27	IS-27	Durg
28	IS-28	Charoda, Raipur
29	IS-29	Sirsa, Bhilai
30	IS-30	Raipur
31	IS-31	Kumhari, Raipur
32	IS-32	Mahasamund
33	IS-33	Durg
34	IS-34	Bhilai, Durg
35	IS-35	Karanja, Bhilai
36	IS-36	Durg
37	IS-37	Bhakma, Mahasamund
38	IS-38	Bhilai
39	IS-39	Bhilai
40	IS-40	Bhilai
41	IS-41	Durg
42	IS-42	Ameri, Durg
43	IS-43	Patan, Durg
44	IS-44	Sirsa, Bhilai
45	IS-45	Rajnandgaon
46	IS-46	Rajnandgaon
47	IS-47	Rajnandgaon
48	IS-48	Rajnandgaon
49	IS-49	Rajnandgaon

50	IS-50	Raigarh
51	IS-51	HARP, Ranchi (Jharkhand)
52	IS-52	Raigarh
53	IS-53	Raigarh
54	IS-54	Raigarh
55	IS-55	Raigarh
56	IS-56	Durg market
57	IS-57	Durg market
58	IS-58	Durg market
59	IS-59	Abhanpur market
60	IS-60	Abhanpur market
61	IS-61	Abhanpur market
62	IS-62	Bilaspur
63	IS-63	Bilaspur
64	IS-64	Dantewada
65	IS-65	Dantewada
66	IS-66	Dantewada
67	IS-67	Dantewada
68	IS-68	Patan, Durg
69	IS-69	Patan, Durg
70	IS-70	Patan, Durg
71	IS-71	Patan, Durg
72	IS-72	Patan, Durg
73	IS-73	Dantewada
74	IS-77	Dantewada
75	IS-79	Dantewada
76	IS-80	Dantewada
77	IS-81	Dantewada
78	IS-83	Dantewada
79	IS-86	Dantewada
80	IS-87	Dantewada
81	IS-88	Dantewada
82	IS-89	Dantewada
83	IS-90	Dantewada
84	IS-91	Dantewada
85	IS-92	Dantewada
86	IS-96	Bilaspur
87	IS-97	Bilaspur
88	IS-98	Bilaspur
89	IS-99	Bilaspur
90	IS-100	Bilaspur
91	IS-101	Jashpur
92	IS-102	Jashpur
93	IS-103	Jashpur
94	IS-104	Bijapur
95	IS-105-1	Bijapur
96	IS-105-2	Bijapur
97	IS-105-3	Bijapur
98	2013/DOL PVAR-1	A.I.C.R.P on Vegetable Crops
99	2013/DOL PVAR-3	A.I.C.R.P on Vegetable Crops
100	Pusa Early Prolific	A.I.C.R.P on Vegetable Crops I.G.K.V., Raipur (C.G.)

3.7 Observations procedure

Observations on metric traits were recorded on single plant basis on five random selected competitive plants in each genotype from each plot for all the traits separately. More over observation on first flowering were recorded on plot basis.

The following observations were recorded as per the NBPGR descriptor for germplasm and varietal evaluation of vegetable crops as per IIVR (Mathura Rai *et al.*, 2004).

3.7.1 Days to first flowering

Days to first flowering was noted from the date of sowing to the first flowering appearance in each plant of a row.

3.7.2 Days to 50% flowering

This was noted as number of days from sowing date to the date when 50% plant sown atleast one flower open.

3.7.3 Pedicel length (cm)

This was noted in continue of flowering, pod formation and marketable green pod harvest stage, as average of same five plants randomly.

3.7.4 Inflorescence length (cm)

This was recorded in centimeter in five randomly selected inflorescence from five random selected competitive tagged plants and averaged.

3.7.5 Number of flower per inflorescence

Flowers of ten randomly selected inflorescence of already tagged five random competitive plants were counted and averaged.

3.7.6 Number of pods per inflorescence

Pods of ten randomly selected inflorescence in five random competitive plants were counted and averaged.

3.7.7 Pod colour

This was noted at marketable stage as White, Creamish, Light green, Greenish and Purple.

3.7.8 Pod width shape

This was noted at marketable stage as Straight, Curved, Intermediate, Flat, Round or others

3.7.9 Pod lenth shape

This was noted at marketable stage as Straight, Curved, Highly curved or other (Specify in the 'Remarks' descriptor).

3.7.10 Pod length (cm)

This was noted as average of 10 random selected tagged pods at marketable stage.

3.7.11 Pod width (cm)

This was noted as average of width of same 10 randomly selected pods at marketable stage.

3.7.12 Days to first pod harvest

This was noted as number of days from sowing date to the date of first pod picking at marketable stage.

3.7.13 Days to last pod harvest

This was noted as number of days from sowing dates to the date of last pod picking at marketable stage.

3.7.14 Number of pods per plant

This was noted as average of same 10 plants at marketable stage.

3.7.15 Number of green pod picking

This was noted as total number of pod picking at marketable stage.

3.7.16 10 pod weight (g)

Weight of 10 green marketable pods of already tagged five random competitive plants was recorded in gram and averaged.

3.7.17 Green pod yield per plant (g)

Weight of green marketable pods of already tagged five random competitive plants was recorded in gram and averaged.

3.7.18 Pod yield (kg/plot)

This was noted as average of cumulative green marketable pod yield of all pickings.

3.7.19 Pod yield (kg/ha)

This was noted on the basis cumulative yield of per plot and converted to kg. per hectare.

3.7.20 Number of seeds per pod

Seeds of ten randomly selected matured pods of already tagged five randomly selected competitive plants were counted and averaged.

3.7.21 100 seed weight (g)

This was noted as weight of 100 random mature and dry seeds quantitative for individual genotype.

3.8 Statistical and Biometrical analysis

3.8.1 Analysis of variance

The data collected from different characters were processed and analysed by the method of analysis of variance as derived by Cochran and Cox (1957).

The skeleton of analysis of variance for Randomized Block Design (RBD)

Source of variation	**Degree of freedom**	**Sum of squares**	**Mean sum of squares**	**F value**	
				Calculated	**Tabulated at 5% and 1%**
Replication	(r-1)	SS_r	MS_r	MSr / MS_e *****Significant at 5%	
Treatment	(t-1)	SS_t	MS_t	M S_t / MS_e******Significant at 1%	
Error	(r-1)(t-1)	SS_e	MS_e		
Total	(rt-1)				

Where,

r = Replication t = Treatments

SS_r= Replication sum of squares SS_t= Treatment sum of squares

SS_e= Error sum of squares MS_r= Replication mean sum of squares

MS_e= Error mean sum of squares MS_t = Treatment mean sum of squares

To test the significance of treatment differences, calculated value of 'F' was compared with tabular value of 'F' at 5 and 1 per cent levels of probability, against error degree of freedom, *i.e*. (r-1) (t-1).

3.8.2 Coefficient of variation

The genotypic and phenotypic coefficients of variation were calculated using formula as suggested by Burton (1952).

$$GCV(\%) = \frac{\sqrt{\sigma 2g}}{\bar{x}} \times 100$$

$$PCV(\%) = \frac{\sqrt{\sigma 2p}}{\bar{x}} \times 100$$

Where,

GCV = Genotypic coefficient of variation

PCV = Phenotypic coefficient of variation

$\overline{X}$ = Mean of the character

$\sigma^2 g$ = Genotypic variance

$\sigma^2 p$ = Phenotypic variance

3.8.3 Biometrical parameter of variation

3.8.3.1 Range

The range of distribution was by the limit of the smallest and the largest value of each observation.

3.8.3.2 Mean

This mean was calculated by summing up all the observations and dividing the sum by the number of observations.

3.8.4 Heritability

Heritability in broad sense (h^2) is defined as the property of the genotypic variance to the total variance (phenotypic variance). This was estimated by using the formula given by Burton and De Vane (1953)

$$h^2 (bs) = \frac{\sigma^2 g}{\sigma^2 p} \text{ X } 100$$

Where,

h^2 (bs) = Heritability in broad sense

$\sigma^2 g$ = Genotypic variance

$\sigma^2 p$ = Phenotypic variance

The broad sense heritability estimates were categorized as low, moderate and high as follow:

<50%= Low heritability

50-70%=Moderate heritability

>70%= High heritability

3.8.5 Genetic advance

Improvement in the mean genotype value of selected plants over the parental

population is known as genetic advance. Expected genetic advance (GA) was calculated as per the method suggested by Johnson *et al.* (1955).

$$GA = K.\ \sigma p\ h^2$$

Where,

K = Constant (standard selection differential) having value of 2.06 at 5% selection intensity

σp = Phenotypic standard deviation

h^2 (bs) = Heritability estimates in broad sense

3.8.6 Genetic advance as percentage of mean

$$\text{GA as percentage of mean} = \frac{GA}{\overline{X}} \times 100$$

Where, *GA* = Expected Genetic advance

$\overline{X}$ = Mean of the character

Range	Category
>20 per cent	High
10-20 per cent	Moderate
<10 per cent	Low

3.8.7 Estimates of correlation coefficient

Correlation coefficient (r) was calculated for all possible combination of fruit yield and its component parameters by using the standard procedure given by Searle (1961)

$$r_{(x, y)} = \frac{\text{Cov. } (x,y)}{\sqrt{\text{Var}(x) \cdot \text{Var}(y)}}$$

Where,

$r_{(x, y)}$ = Correlation coefficient between character x and y

Var(x) = Variance of x character

Var(y) = Variance of y character

3.8.8 Test of significance

Phenotypic and genotypic coefficients were tested for their significance 't' test as follows

$$t_c = r \sqrt{\frac{n-2}{1-r^2}}$$

at (n -2) degree of freedom

where, n = Number of genotype

If 't' calculated (t_c) is greater than't' tabulated (t_t) at (n -2) degree of freedom at given probability level the phenotypic correlation is taken as significant.

The calculated (r) is then compared with table value of 'r' at 5% and 1% level of significance (Snedecor and Cochran, 1967).

3.8.9 Path-coefficient analysis

The genotypic correlation coefficients were further partitioned into direct and indirect effects with the help of path coefficient analysis as suggested by Wright (1921) and elaborated by Dewey and Lu (1959). Path coefficient was calculated separately for all important characters considering fruit yield as dependable variable.

Path-coefficient was estimated using simultaneous equations and the equations showed a basic relationship between correlation coefficient and path-coefficient. These equations were solved by presenting them in matrix notations.

$A = B.C$

The solution for the vector 'C' may be obtained by multiplying both sides by inverts of 'B' matrix *i.e.* $B^{-1}.A = C$. After calculation of values of path-coefficient *i.e.* 'C' vector, it is possible to obtain path values for residual (R). Residual effect was

calculated using formula from Singh and Chaudhary (1985).

$$R = \sqrt{1 - \sum di \times r_{ij}}$$

Where,

di = direct effect of i^{th} character

rij = correlation coefficient of i^{th} character with j^{th} character

Direct and indirect effects of different characters on fruit yield were calculated at genotypic level.

3.8.10 Genetic divergence analysis

The Mahalanobis (1936) D^2 statistic was used to measure the genetic divergence between the populations. The D^2 value was estimated on the basis of 'P' character by the formula:

Formula:

$$D^2 P = \sum_{i=1}^{p} = \sum_{j=1}^{p} = (\lambda ij)\, \lambda i \lambda j$$

Where,

(λ i, j) is the reciprocal or (λ i, j), the pooled common dispersion matrix (i.e. error matrix)

i = the difference in the mean value for the i^{th} character

j = the difference in the mean value for the j^{th} character

For calculating the D^2 values, the variance and covariance were calculated. The genotypes were grouped into different clusters by Tocher's method. The population was arranged in order of their relative distances from each other. For including a particular population in the clusters, a level of D^2 was fixed by taking the maximum D^2 values between any two populations in the first row of the table where D^2 values were arranged in increasing order of magnitude.

Results and Discussion

CHAPTER- IV

RESULTS AND DISCUSSION

Dolichos bean or Sem (*Lablab purpureus* L.) is an important leguminous vegetable crop grown throughout the country and distributed in Madhya Pradesh, Maharastra, Andhra Pradesh, Tamil Nadu and North Eastern states. Sem is grown for its edible pods as vegetable for human consumption or as animal forage or feed. It has great range of variation for the plant and pod characters among the wild species and cultivars grown all over the country.

Vavilov (1939) had considered India as the primary centers of origin of dolichos bean and wild forms are found in many parts of the country. Chhattisgarh state has wide genetic variability for various traits like plant habit, branching habit, stem pigmentation, leaf veination, flower colour, pod colour, pod characters, *viz.*, shape, size, weight and seeds per pod etc.

Although this crop has originated in India but very little work has been done for the genetic improvement in yield and quality. Marked variation exists in the plant and pod characters among the cultivars grown all over the country.

In Chhattisgarh, genetic diverisity of dolichos bean provides a better opportunity for crop improvement. Therefore, a systematic breeding programme should be initiated to use the genetic resources of dolichos bean in this state.

Upadhyay (2008), Patel (2010) and Bhagat (2011) reported that little work has been done for collection and genetic improvement of dolichos bean in Chhattisgarh.

In the present investigation, efforts are being made to assess extent of genetic variability for various traits including green pod yield and seed, also their component characters as well as other morphological characters. It is also important that

considerable variability for economic traits must exist in the gene bank for better exploitation and identification of suitable divergent parents which can be used for further hybridization programme.

The results obtained on various aspects from present investigation are presented through appropriate tables and graphs and are briefly discussed under the following heads:

4.1 Analysis of variance

4.2 Mean performance of genotypes

4.3 Genetic parameters of variation

4.4 Correlation coefficient analysis

4.5 Path coefficient analysis

4.6 Genetic divergence analysis

4.1 Analysis of variance

Results of analysis of variance for green pod yield and its components indicated (Table 4.1) that mean sum of squares due to genotypes were found to be significant for all the traits and indicated presence of sufficient amount of variability among the genotypes for green pod yield and its components traits. Hence, selection is very effective for improvement of green pod yield and its component characters in dolichos bean.

These findings are in general agreement with the findings of Pandita *et al.* (1980), Wahabuddin *et al.* (1986), Borah *et al.* (1992), Bendal *et al.* (2008), Upadhyay (2008), Patel (2010) and Bhagat (2011).

4.2 Mean performance of genotypes

The mean performance of all the genotypes compared with checks for green pod yield and its components are presented in table 4.2 and 4.3 and discussed here as under:

Table 4.1 Analysis of variance for green pod yield and its components in Dolichos bean

S. No.	Character	Mean sums of square		
		Replication	Genotypes	Error
	(df)	(2)	(99)	(198)
01	Days to first flowering	5.63**	448.75**	3.11
02	Days to 50% flowering	1.00	446.53**	4.14
03	Inflorescence length (cm)	0.48	96.75**	1.14
04	No. of flower per inflorescence	4.73**	95.69**	1.08
05	No. of pod per inflorescence	1.34**	8.63**	0.21
06	Pedicel length (cm)	23.57**	19.48**	371.85
07	Pod length (cm)	1.09**	25.58**	0.10
08	Pod width (cm)	3.03**	0.18**	84.27
09	Number of seed per pod	0.24**	0.62**	2.50
10	10 pod weight (g)	128.63**	1463.01**	10.95
11	Number of pod per plant	35.23**	374.61**	64.75
12	Number of green pod picking	26.80**	26.58**	0.24
13	Pod yield per plant (g)	136.00**	6052.66**	76.00
14	100 seed weight (g)	49.21**	168.38**	19.81
15	Days to first pod harvest	11.63**	430.39**	3.99
16	Days to last pod harvest	70.00**	278.74**	12.32

*** Significant at 5%, ** significant at 1%**

4.2.1 Days to first flowering

Earliest flowering was recorded in genotypes IS-32 (45 days) which was followed by IS-21 (46.67 days), IS-36 (62.67 days) and IS-59 (65.67 days) and on the other hand maximum days to first flower was noted in IS-31 (116 days) whereas, check Swarna Utkrishti appears first flowering in 67 days.

4.2.2 Days to 50% flowering

Earliest 50% flowering was recorded in genotypes IS-21 (51.33 days) which was followed by IS-32 (52.33 days), and on the other hand maximum days to 50% flowering was noted in IS-70 (123.33 days) whereas, check Swarna Utkrishti appears 50% flowering in 74.67 days.

4.2.3 Inflorescence length (cm)

Inflorescence length ranged from 4.15 cm to 26.93 cm. Highest inflorescence length was recorded in IS-48 (26.93 cm) followed by IS-02 (26.21 cm), and IS-1 (25.03 cm) whereas, minimum length of inflorescence was recorded in IS-37 (4.15 cm) with overall mean of 17.45 cm and check Swarna Utkrishti showed 23.87 cm.

4.2.4 No. of flower per inflorescence

Number of flower per inflorescence ranged from 8.93 to 35.87. Number of flower per inflorescence was recorded maximum in IS-48 (35.87) which was followed by IS-79 (30.70) and IS-38 (30.47) whereas, minimum number of flower recorded in IS-37 (8.93) with, the general mean of 20.57 whereas, check Swarna Utkrishti bear 24.47 flower per inflorescence.

4.2.5 No. of pod per inflorescence

Number of pods per inflorescence ranged from 2.60 to 10.63. Maximum number of pod per inflorescence was recorded in IS-27 (10.63) which was followed by IS-01 (10.13) and IS-40 (9.93) whereas, minimum number of pod per

inflorescence was recorded in IS-72 (2.60) with general mean of 6.12 whereas, check Swarna Utkrishti recorded 9.17 pods per inflorescence.

4.2.6 Pedicel length (cm)

Pedicel length ranged from 0.19 cm to 0.33 cm. Maximum pedicel length recorded in IS-2 and IS-104 (0.33 cm) which was followed by IS-105-1 (0.32 cm), IS-21 (0.31 cm), IS-77 (0.31 cm) and 2013/DOL PVAR-3 (0.31 cm) whereas, minimum pedicel length was recorded in IS-79 (0.19 cm), with overall mean of 0.25 cm and check Swarna Utkrishti showed 0.23 cm pedicel length.

4.2.7 Pod length (cm)

Pod length ranged from 4.41 cm to 17.40 cm. Maximum pod length was recorded in 2013/DOL PVAR-3 (17.40 cm) followed by IS-43 (16.90 cm), IS-96 (16.56 cm), and IS-33 (16.11 cm) whereas, minimum pod length recorded in IS-08 (4.41 cm), with overall mean of 9.98 cm and check Swarna Utkrishti showed 11.81 cm pod length.

4.2.8 Pod width (cm)

Pod width ranged from 1.49 cm to 2.74 cm. Maximum pod width was recorded in IS-30 (2.74 cm) followed by IS-72 (2.62 cm) and IS-104 (2.60 cm) whereas, minimum pod width recorded in IS-87 (1.49 cm) with overall mean of 2.01 cm and check Swarna Utkrishti showed 2.35 cm pod width.

4.2.9 Number of seeds per pod

Number of seeds per pod ranged from 3.60 to 6.20. Maximum number of seeds per pod was counted in IS-77 (6.20) which was followed by IS-81 (6.07) and IS-17 (5.87) whereas, minimum number of seeds per pod was counted in IS-64 (3.60) with overall mean of 4.83 and check Swarna Utkrishti recorded 3.75 number of seeds per pod.

4.2.10 10 pod weight (g)

10 pod weight ranged from 30.67 g to 148.33 g. Maximum 10 pod weight was recorded in IS-30 (148.33 g) which was followed by IS-53 (115 g), IS-50 (112 g) and IS-65 (108.33 g) whereas, minimum 10 pod weight was recorded in IS-8 (30.67 g) with overall mean of 68.84 g and check Swarna Utkrishti recorded 85 g 10 pod weight.

4.2.11 Number of pods per plant

Number of pods per plant ranged from 11.67 to 75.67. Maximum number of pod per plant was counted in IS-01 (75.67) which was followed by IS-18 (57.67), IS-04 (55.33) and IS-64 (54.33) whereas, minimum number of pods per plant recorded in 2013/DOL PVAR-3 (11.6) with general mean of 31.49 and check Swarna Utkrishti recorded 21 number of pods per plant.

4.2.12 Number of green pod picking

Number of green pod picking ranged from 6 to 12. Maximum number of green pod picking was recorded in IS-32 (12) which was followed by IS-21 (11.33), IS-51 or Swarna Utkrishti (10) and IS-58 (9) whereas, minimum number of green pod picking was recorded in IS-13, IS-15, IS-31 and IS-52 (6) with general mean of 7.36 and check Swarna Utkrishti showed 10 number of green pod picking.

4.2.13 Pod yield per plant (g)

Pod yield per plant ranged from 118.67 g to 276.67 g. Maximum green pod yield per plant was recorded in IS-14 (276.67 g) which was followed by IS-11 (274.67 g), IS-2 (272.67 g) and IS-18 (271 g) whereas, minimum green pod yield per plant 118.67 g recorded in 2013/DOL PVAR-3 with general mean of 199.33 g and check Swarna Utkrishti recorded 176.33 g pod yield per plant.

4.2.14 Pod yield (kg/plot)

Pod yield per plot ranged from 7.15 kg to 16.62 kg. Maximum pod yield per plot was recorded in IS-14 (16.62 kg) which was followed by IS-11 (16.51 kg), IS-2 (16.38 kg) and IS-18 (16.28 kg) whereas, minimum pod yield per plot was recorded in 2013/DOL PVAR-3 (7.15kg) with general mean of 11.98 kg and check Swarna Utkrishti recorded 10.61 kg pod yield per plot.

4.2.15 Pod yield (kg/ha)

Pod yield kg per hectare ranged from 6623.66 kg to 15415.33 kg. Maximum pod yield per hectare was recorded in IS-14 (15415.33 kg) which was followed by IS-11 (15293.33 kg) and IS-2 (15169.67 kg) whereas, minimum pod yield per hectare was recorded in 2013/DOL PVAR-3 (6623.66 kg) with general mean of 11100 kg and Swarna Utkrishti recorded 9833.33 kg pod yield per hectare.

4.2.16 100 seed weight (g)

100 seed weight ranged from 23.33 g to 53.67 g. 100 seed weight recorded maximum for IS-38 (53.67 g) which was followed by IS-04 (53 g), IS-45 (52.67) and IS-24 (52.33 g) whereas, minimum seed weight noticed in Swarna Utkrishti 23.33 g with overall mean of 37.72 g.

4.2.17 Days to first pod harvest

Days to first pod harvest ranged from 58 days to 129.67 days. The first pod harvest was recorded in IS-32 which was 58 days after sowing followed by IS-21 (62.33 days), IS-51 (78.33 days), and Pusa Early Prolific (79 days) whereas, IS-31 taken 129.67 days for first pod harvest, is last genotype in term of days to first pod harvest. The overall mean for this attribute was 111.88 days after sowing.

4.2.18 Days to last pod harvest

Days to last pod harvest ranged from 149.33 days to 208.33 days. The early last pod harvest days were recorded in IS-36 (149.33 days) after sowing which was

Table 4.2 Mean performance of green pod yield and its components in Dolichos bean

Character No. →		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
S. No.	Genotype ↓	Days to first flower -ing	Days to 50% flower -ing	Inflores cence length (cm.)	No. of flower/ Infloresc ence	No. of pods / Infloresc ence	Pedicel length (cm)	Pod length (cm)	Pod width (cm)	No. of seed / Pod	10 Pod weight (g)	No. of pods/ plant	No. of green pod picking	Green pod yield/ Plant (g)	Pod yield (kg/ plot)	Pod yield (kg/ha)	100 seed weight (g)	Days to first pod harvest	Days to last pod harvest
01	IS-01	102.67	109.00	25.03	24.70	10.13	0.23	06.69	2.07	4.23	033.33	75.67	07.67	253.00	15.25	14117.00	35.00	114.67	194.67
02	IS-02	106.00	110.67	26.21	25.70	06.50	0.33	15.16	2.07	5.43	089.00	31.67	08.33	272.67	16.38	15169.67	45.00	117.67	202.00
03	IS-03	107.33	113.67	17.04	19.30	08.00	0.27	07.71	2.05	4.60	050.67	38.33	08.33	195.00	11.73	10863.33	36.33	119.67	204.33
04	IS-04	109.00	112.67	17.50	18.10	05.20	0.25	08.21	2.05	5.37	045.67	55.33	08.33	246.67	14.84	13747.33	53.00	120.67	208.33
05	IS-05	102.00	110.00	24.60	24.10	06.63	0.27	08.23	2.13	4.80	053.33	42.67	07.67	227.67	13.68	12665.00	37.33	114.33	194.33
06	IS-06	101.67	109.33	22.83	21.33	06.50	0.24	07.86	2.26	4.53	056.67	35.67	07.33	202.33	12.18	11280.67	35.33	117.00	193.00
07	IS-07	098.67	105.00	20.17	21.67	07.53	0.29	06.87	2.10	4.67	059.67	41.33	09.00	246.67	14.84	9066.22	35.00	109.67	201.33
08	IS-08	094.33	105.67	17.30	19.47	08.37	0.22	04.41	2.12	3.97	030.67	46.00	07.67	141.00	08.49	7881.00	31.00	108.33	189.33
09	IS-09	106.00	114.33	23.20	23.40	08.30	0.23	07.11	2.09	4.67	052.33	42.00	07.00	221.67	13.34	12354.67	31.33	120.00	195.00
10	IS-10	104.67	112.33	21.17	23.20	09.33	0.26	06.99	1.87	4.50	050.00	37.00	07.33	187.00	11.26	10435.33	36.00	119.67	196.33
11	IS-11	093.00	100.67	17.83	17.80	04.83	0.24	07.38	1.79	4.90	050.67	53.67	07.00	274.67	16.51	15293.33	43.67	108.33	183.33
12	IS-12	095.67	103.67	25.03	24.47	06.33	0.27	14.61	2.01	5.27	090.00	30.00	07.00	266.33	16.01	14826.33	42.67	110.00	184.33
13	IS-13	102.33	109.67	16.86	23.43	07.47	0.22	09.56	2.07	4.63	053.67	30.00	06.00	160.33	09.65	8941.00	36.00	115.33	181.00
14	IS-14	104.67	110.67	17.50	16.77	06.83	0.24	08.41	1.82	5.00	056.67	48.67	07.00	276.67	16.62	15415.33	35.67	115.00	189.33
15	IS-15	105.00	112.33	21.00	23.57	06.90	0.23	08.86	2.01	4.53	059.00	23.67	06.00	139.67	08.40	7774.00	35.33	119.33	181.67
16	IS-16	101.00	104.33	19.13	21.40	07.63	0.25	07.37	2.50	4.53	062.67	27.33	06.67	170.67	10.26	9499.00	32.33	113.00	182.00
17	IS-17	103.00	107.33	20.50	23.67	06.43	0.29	13.80	2.01	5.87	096.67	26.00	07.33	251.33	15.10	13988.67	45.00	116.67	188.00
18	IS-18	098.33	104.33	24.57	25.80	08.97	0.25	08.31	1.97	4.87	046.67	57.67	07.67	271.00	16.28	15078.67	33.33	113.00	195.67
19	IS-19	088.67	092.67	19.47	18.77	09.37	0.23	07.97	1.81	4.33	038.67	41.33	07.67	161.00	10.00	8972.00	33.33	103.67	181.33
20	IS-20	103.00	108.00	20.33	23.83	07.17	0.23	08.69	1.77	4.63	055.33	47.67	06.33	264.67	16.00	14726.00	39.33	120.00	186.67
21	IS-21	046.67	051.33	24.41	26.00	07.47	0.31	08.51	1.72	4.20	046.00	36.67	11.33	168.33	10.00	9395.00	25.00	062.33	179.67

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Table 4.2 Mean performance of green pod yield and its components in Dolichos bean

Character No. →		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
S. No.	Genotype ↓	Days to first flower -ing	Days to 50% flower -ing	Inflores cence length (cm.)	No. of flower/ Inflore scence	No. of pods / Inflore scence	Pedicel length (cm)	Pod length (cm)	Pod width (cm)	No. of seed / Pod	10 Pod weight (g)	No. of pods/ plant	No. of green pod picking	Green pod yield/ Plant (g)	Pod Yield (kg/ Plot)	Pod yield (kg/ha)	100 seed weight (g)	Days to first pod harvest	Days to last pod harvest
22	IS-22	108.67	115.00	23.57	25.57	06.63	0.25	08.05	1.68	4.43	040.67	49.33	08.00	201.67	12.00	11175.00	26.67	122.00	202.67
23	IS-23	104.33	112.33	09.77	10.23	05.10	0.25	10.22	1.90	5.07	062.33	34.67	06.33	220.33	13.00	12263.00	37.33	119.67	186.67
24	IS-24	098.33	106.67	06.93	13.67	06.23	0.24	11.44	1.96	5.23	060.00	33.67	07.00	203.33	12.00	11508.00	52.33	114.67	186.67
25	IS-25	106.33	112.67	21.33	17.07	05.80	0.26	10.94	2.07	4.83	058.33	43.33	06.67	254.33	15.00	14121.00	34.33	120.00	194.33
26	IS-26	103.00	113.00	20.23	26.40	08.37	0.23	11.15	2.15	5.03	084.33	22.67	07.33	192.00	12.00	10700.00	44.67	119.67	194.67
27	IS-27	094.33	104.33	22.53	20.90	10.63	0.28	11.86	1.70	4.80	081.67	21.33	07.33	172.33	10.00	9586.00	42.67	115.00	191.00
28	IS-28	102.67	108.33	23.52	24.70	06.40	0.25	10.54	2.19	4.60	070.67	37.67	07.00	269.67	16.00	15001.00	46.33	117.67	192.00
29	IS-29	103.67	108.00	10.87	11.10	05.87	0.26	11.07	2.43	4.77	086.67	24.67	08.00	212.33	13.00	11851.00	50.67	118.33	199.00
30	IS-30	095.00	102.33	06.23	10.33	04.90	0.29	13.91	2.74	4.70	148.33	15.33	07.00	225.00	14.00	12516.00	47.00	107.67	179.67
31	IS-31	116.00	122.33	19.58	22.73	06.67	0.26	09.27	2.03	4.43	73.00	29.33	06.00	214.33	13.00	11949.00	38.33	129.67	194.67
32	IS-32	045.00	052.33	20.63	24.87	07.67	0.26	08.00	1.84	4.90	053.33	29.00	12.00	154.67	9.00	8621.00	23.67	058.00	180.67
33	IS-33	097.00	104.67	10.57	11.00	06.77	0.23	16.11	2.03	5.67	096.67	25.67	08.33	248.33	15.00	13863.00	50.67	116.67	202.33
34	IS-34	094.67	105.00	07.56	13.93	06.27	0.24	08.64	2.14	5.17	071.67	34.00	08.00	246.00	15.00	13693.00	40.33	114.00	196.00
35	IS-35	095.67	103.00	15.70	23.67	05.27	0.21	09.25	1.74	4.67	061.33	36.00	07.00	223.00	13.00	12428.00	38.67	109.33	184.00
36	IS-36	062.67	071.33	24.00	27.07	08.90	0.23	08.76	1.96	4.47	060.67	23.33	06.33	142.00	09.00	7903.00	32.00	080.67	149.33
37	IS-37	105.33	113.33	04.15	08.93	05.10	0.24	10.93	2.04	5.17	076.67	27.33	08.33	209.33	13.00	11667.00	32.67	118.67	204.33
38	IS-38	107.00	115.67	21.00	30.47	04.60	0.22	10.28	2.25	5.07	083.33	32.67	07.33	270.67	16.00	15061.00	53.67	122.33	199.67
39	IS-39	095.67	104.00	23.97	25.77	07.97	0.24	05.85	1.99	4.43	047.33	47.67	07.33	227.67	14.00	12661.00	33.00	111.33	188.00
40	IS-40	104.67	112.33	21.67	27.47	09.93	0.24	06.30	2.01	4.40	046.67	46.67	06.33	220.00	13.00	12258.00	34.00	121.67	187.67
41	IS-41	096.33	104.00	09.33	10.87	05.40	0.26	10.58	2.32	4.60	085.00	29.00	07.00	245.67	14.74	13649.33	49.67	112.67	187.00
42	IS-42	098.67	106.67	19.43	26.53	06.83	0.22	11.05	2.16	4.83	089.00	26.33	08.00	231.00	13.88	12851.00	46.33	111.67	193.67

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Table 4.2 Mean performance of green pod yield and its components in Dolichos bean

Character No. →		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
S. No.	Genotype ↓	Days to first flower -ing	Days to 50% flower -ing	Inflores cence length (cm.)	No. of flower/ Inflore scence	No. of pods / Inflors cence	Pedicel length (cm)	Pod length (cm)	Pod width (cm)	No. of seed / Pod	10 Pod weight (g)	No. of pods/ plant	No. of green pod picking	Green pod yield/ Plant (g)	Pod yield (kg/ Plot	Pod yield (kg/ha)	100 seed weight (g)	Days to first pod harvest	Days to last pod harvest
43	IS-43	097.33	105.00	14.63	21.03	04.60	0.27	16.90	2.02	5.30	105.00	22.33	07.33	230.67	13.88	12859.66	48.33	115.00	192.67
44	IS-44	103.33	111.33	09.05	13.03	06.60	0.23	06.70	2.11	4.40	037.33	34.33	06.33	127.67	07.69	7121.33	28.67	119.33	185.33
45	IS-45	110.00	116.00	10.25	14.23	04.60	0.24	11.26	2.55	5.40	102.67	19.33	07.00	195.00	11.71	10852.33	52.67	121.67	193.67
46	IS-46	093.00	099.00	20.20	23.90	06.90	0.24	07.09	1.91	4.57	037.33	50.33	07.00	189.00	11.35	10510.33	31.33	107.00	179.67
47	IS-47	111.33	118.67	12.29	17.20	04.33	0.24	08.51	1.87	4.30	040.00	44.00	07.00	177.33	10.66	9880.66	36.33	125.00	195.33
48	IS-48	101.67	108.67	26.93	35.87	07.90	0.27	15.59	2.10	5.73	103.33	13.00	06.33	126.33	07.32	6787.00	44.33	116.67	184.33
49	IS-49	095.67	104.00	17.27	18.73	07.87	0.25	07.97	2.04	4.57	056.67	31.67	06.67	214.67	12.89	11946.00	36.33	108.33	177.00
50	IS-50	100.00	109.00	06.70	12.37	05.07	0.25	14.78	2.36	5.50	112.00	22.33	06.33	261.33	15.70	14544.33	49.67	118.00	181.67
51	IS-51	067.00	074.67	23.87	24.47	09.17	0.23	11.81	2.35	5.40	085.00	21.00	10.00	176.33	10.61	9833.33	23.33	078.33	181.00
52	IS-52	109.00	106.67	19.79	26.30	06.90	0.22	08.68	2.15	5.37	084.67	20.67	06.00	172.67	10.36	9601.66	31.67	121.67	184.00
53	IS-53	103.00	109.67	09.06	11.47	05.80	0.25	10.89	1.81	4.67	115.00	18.33	07.00	202.33	12.17	11270.33	40.33	116.00	186.00
54	IS-54	097.00	106.67	16.74	21.50	05.80	0.26	08.70	1.91	4.47	053.33	50.00	08.00	269.00	16.17	14978.66	31.33	114.33	198.33
55	IS-55	094.33	103.67	14.78	17.30	05.13	0.25	11.26	1.79	4.47	055.00	34.33	07.00	189.33	11.38	10514.66	27.33	110.33	185.00
56	IS-56	091.00	100.67	22.31	25.07	06.27	0.27	11.02	1.78	5.23	058.00	36.00	07.33	211.33	12.70	11764.33	31.00	109.33	185.33
57	IS-57	093.33	100.33	19.89	23.43	05.83	0.23	10.20	2.04	4.60	057.33	27.67	07.33	171.33	10.31	9548.33	32.67	105.00	177.67
58	IS-58	066.00	074.33	17.16	18.40	05.43	0.25	11.58	1.99	5.20	067.67	20.67	09.00	135.33	08.13	7533.66	32.33	080.67	173.33
59	IS-59	065.67	072.00	14.77	19.23	05.17	0.29	10.58	2.02	5.13	092.67	21.33	08.00	196.67	11.82	10948.00	52.00	086.00	165.67
60	IS-60	097.33	104.67	18.77	21.73	05.37	0.25	10.75	2.44	4.57	097.67	24.33	08.00	236.67	14.24	13196.66	47.33	111.67	195.33
61	IS-61	103.33	111.67	16.33	23.67	05.90	0.25	07.04	2.23	4.33	060.00	25.33	07.67	151.00	09.07	8408.33	27.00	119.00	193.67
62	IS-62	100.00	107.00	23.97	24.83	05.50	0.27	11.11	2.39	4.50	079.00	24.00	08.00	191.00	11.63	10773.33	49.00	113.33	197.00
63	IS-63	097.67	105.67	20.63	25.87	05.57	0.27	10.02	2.00	4.53	066.67	31.00	08.00	207.00	12.43	11515.66	48.67	119.00	201.67

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Table 4.2 Mean performance of green pod yield and its components in Dolichos bean

Character No. →		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
S. No.	Genotype ↓	Days to first flower -ing	Days to 50% flower ing	Inflores cence length (cm.)	No. of flower/ Inflore scence	No. of pods/ Inflors cence	Pedicel length (cm)	Pod length (cm)	Pod width (cm)	No. of seed / Pod	10 Pod weight (g)	No. of pods/ plant	No. of green pod picking	Green pod yield/ Plant (g)	Pod yield (kg/ Plot)	Pod yield (kg/ha)	100 seed weight (g)	Days to first pod harvest	Days to last pod harvest
64	IS-64	097.00	104.00	22.97	27.30	09.17	0.23	05.90	1.69	3.60	036.00	54.33	07.67	198.33	11.93	11055.66	24.00	113.67	196.00
65	IS-65	097.00	104.33	19.97	25.90	05.50	0.26	15.76	1.99	5.43	108.33	23.00	07.67	249.00	14.96	13860.00	41.67	111.00	190.67
66	IS-66	099.00	106.33	17.43	20.13	05.43	0.26	14.81	1.88	5.53	075.67	34.00	07.33	257.67	15.46	14321.00	39.33	111.00	190.00
67	IS-67	107.00	113.33	22.37	28.57	04.40	0.25	07.26	2.07	4.57	062.33	22.67	07.33	138.33	08.32	7712.66	42.00	120.33	194.67
68	IS-68	098.00	106.00	19.67	24.90	04.93	0.26	09.31	1.97	4.60	101.67	24.67	07.33	252.00	15.14	14024.66	41.00	112.67	188.33
69	IS-69	113.00	120.67	08.65	12.40	04.47	0.26	11.69	1.72	5.60	042.33	31.00	06.33	132.00	07.94	7359.00	33.33	124.33	192.67
70	IS-70	115.00	123.33	08.49	11.30	04.07	0.25	12.58	1.54	5.07	062.33	24.67	06.33	153.67	09.24	8563.00	41.67	126.33	195.67
71	IS-71	114.00	121.33	05.89	09.27	03.50	0.23	10.42	1.74	4.73	079.00	17.00	06.33	130.00	07.82	7243.33	43.67	126.00	194.67
72	IS-72	115.00	122.00	04.98	10.90	02.60	0.27	07.87	2.62	4.97	052.00	23.00	06.33	119.00	07.17	6648.00	32.33	126.67	194.33
73	IS-73	098.00	105.00	18.05	14.07	03.17	0.27	10.27	1.71	4.90	060.00	21.67	07.00	127.33	07.65	7093.00	42.67	110.33	190.33
74	IS-77	098.00	106.00	23.37	26.83	08.37	0.31	14.62	1.63	6.20	085.00	30.67	06.67	260.00	15.62	14467.00	42.33	113.00	185.00
75	IS-79	100.00	107.00	24.34	30.70	04.50	0.19	07.20	1.82	4.50	054.00	32.67	07.33	164.00	09.86	9133.66	39.67	117.33	187.33
76	IS-80	104.00	113.00	21.05	21.40	04.57	0.27	11.40	1.76	4.57	069.33	26.00	07.67	179.00	10.76	9969.00	41.33	118.00	196.33
77	IS-81	108.00	115.33	16.07	20.23	09.00	0.30	14.23	1.64	6.07	082.33	30.67	07.00	254.33	15.28	14152.33	39.00	121.00	193.33
78	IS-83	097.00	104.67	12.93	16.80	07.03	0.24	07.01	2.07	5.10	069.00	34.33	07.33	240.33	14.44	13381.33	31.67	113.67	192.00
79	IS-86	095.00	103.67	26.40	29.53	07.20	0.27	11.04	1.51	4.70	048.67	46.67	06.67	230.67	13.87	12842.33	28.67	106.33	178.67
80	IS-87	092.00	100.00	15.98	14.47	04.40	0.23	05.81	1.49	4.70	085.00	21.67	07.33	181.00	10.88	10079.66	26.00	103.67	180.67
81	IS-88	096.00	104.33	23.23	21.77	05.70	0.23	07.94	2.10	4.67	081.67	18.33	06.67	147.67	08.88	8231.33	40.33	114.00	183.67
82	IS-89	102.00	109.00	04.97	11.10	04.37	0.25	10.11	2.17	4.80	095.00	15.67	07.00	143.67	08.64	8007.00	39.00	114.67	189.67
83	IS-90	097.00	105.33	05.92	11.07	03.27	0.24	09.56	2.02	4.60	066.67	37.67	07.33	252.33	15.16	14046.33	38.67	122.00	200.00
84	IS-91	099.00	107.33	11.20	17.50	04.37	0.24	10.72	2.07	4.57	095.00	16.33	06.33	150.00	09.04	8377.00	38.33	113.33	181.33

Cont…

Table 4.2 Mean performance of green pod yield and its components in Dolichos bean

Character No. →		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
S. No.	**Genotype ↓**	**Days to first flower -ing**	**Days to 50% flower -ing**	**Inflores cence length (cm.)**	**No. of flower/ Inflore scence**	**No. of pods / Inflore scence**	**Pedicel length (cm)**	**Pod length (cm)**	**Pod width (cm)**	**No. of seed/ Pod**	**10 Pod weight (g)**	**No. of pods/ plant**	**No. of green pod picking**	**Green pod yield/ Plant (g)**	**Pod yield (kg/ plot)**	**Pod yield (kg/ha)**	**100 seed weight (g)**	**Days to first pod harvest**	**Days to last pod harvest**
85	IS-92	095.00	102.33	20.37	21.40	05.20	0.24	09.89	2.25	5.17	080.67	21.33	07.67	170.00	10.21	9461.00	40.00	109.67	189.33
86	IS-96	094.00	103.33	16.07	21.97	04.93	0.26	16.56	2.01	5.47	105.00	18.00	08.00	186.00	11.17	10347.00	43.33	111.33	195.00
87	IS-97	102.00	109.00	16.03	20.17	04.47	0.25	08.35	1.64	5.03	046.67	36.33	08.00	170.33	10.22	9467.66	28.33	115.67	198.00
88	IS-98	103.00	110.67	18.07	24.90	05.17	0.25	11.22	1.69	4.97	071.67	28.00	07.67	200.67	12.06	11175.66	34.67	119.33	194.67
89	IS-99	093.00	102.00	17.46	21.10	05.27	0.24	06.71	2.10	4.07	041.33	40.33	07.67	166.67	10.02	9281.33	35.00	104.67	184.67
90	IS-100	096.00	105.00	16.60	19.03	04.13	0.25	07.10	1.99	4.73	059.00	27.00	07.33	162.67	09.77	9047.66	34.67	109.00	185.00
91	IS-101	093.00	101.33	15.77	19.40	03.47	0.25	08.14	2.05	4.67	054.33	25.00	07.33	134.00	08.07	7478.00	39.67	107.33	182.00
92	IS-102	095.00	102.67	12.83	16.50	03.90	0.25	11.19	2.07	4.93	084.00	23.00	07.67	188.67	11.34	10501.33	41.67	112.67	192.00
93	IS-103	093.00	100.33	22.37	29.07	04.80	0.26	11.69	1.62	5.40	057.67	32.00	08.00	186.00	11.18	10357.00	38.67	107.67	192.33
94	IS-104	091.00	097.33	16.21	17.17	06.13	0.33	11.90	2.60	4.80	100.00	26.67	07.67	262.33	15.77	14604.66	41.00	109.33	192.67
95	IS-105-1	091.00	098.33	14.03	17.73	04.43	0.32	06.96	1.98	4.13	059.00	26.67	06.33	158.00	09.51	8812.33	28.67	107.67	175.33
96	IS-105-2	090.00	097.33	16.39	22.03	04.27	0.25	07.35	2.03	4.17	047.67	32.67	07.00	157.00	09.43	8740.33	30.67	107.33	177.33
97	IS-105-3	088.00	095.00	18.07	21.80	04.70	0.21	07.10	1.96	4.53	060.00	26.67	06.67	160.00	09.61	8908.66	28.00	102.67	170.00
98	2013/DOL PVAR-1	098.00	107.33	16.30	17.37	05.20	0.27	11.41	2.06	4.57	061.00	27.67	07.00	167.67	10.06	9320.00	33.33	111.00	181.00
99	2013/DOL PVAR-3	085.00	093.33	16.23	18.73	06.47	0.31	17.40	2.33	5.00	107.00	11.67	07.00	118.67	07.15	6623.66	27.00	099.00	174.00
100	Pusa Early Prolific	067.00	075.33	19.00	23.20	06.47	0.27	10.06	1.90	4.53	056.67	30.00	07.33	170.00	10.23	9479.00	27.67	079.00	154.33
Mean		97.21	104.67	17.45	20.57	6.12	0.25	9.98	2.01	4.83	68.84	31.50	7.36	199.33	11.98	11053.00	37.73	111.88	188.52
SEm±		1.02	1.17	0.61	0.60	0.26	0.01	0.18	0.05	0.09	1.91	1.46	0.28	5.03	0.30	526.13	0.81	1.15	2.02
C.D. (P= 0.05)		2.82	3.25	1.71	1.66	0.73	0.03	0.51	0.15	0.25	5.29	4.07	0.78	13.94	0.84	1458.31	2.25	3.20	5.61

followed by IS-105-3 (170 days), IS-58 (173.33 days) and 2013/DOL PVAR-3 (174 days) whereas, late pod harvest day noticed in IS-04 (208.33 days) with overall mean of 190 days for this trait.

In brief, earliest days to first flowering was recorded in IS-32, earliest 50% flowering was recorded in IS-21, whereas IS-48 showed maximum length of inflorescence. Similarly number of flower per inflorescence recorded highest in IS-48. IS-27 was recorded maximum number of pods per inflorescence. Largest pedicel length was recorded in IS-2 and IS-104. Maximum pod length recorded in 2013/DOL PVAR-3, whereas, IS-30 was recorded maximum pod width. Maximum number of pod per plant was recoded in IS-01 whereas, number of seeds per pod was highest in genotype IS-77. Maximum hundred seed weight was noted in IS-38. Finally, IS-14 gave superior performance for marketable green pod yield per plant, pod yield per plot and pod yield kg per hectare.

4.3 Genetic variability

The information on the nature and extent of genetic variability present in the population for desirable characters facilitates in selection for improvement of a crop.

4.3.1 Genotypic and phenotypic coefficient of variation

The knowledge of genotypic and phenotypic coefficient of variation is being useful in designing selection criteria from variable population. In general, it was noted that the value of phenotypic coefficient of variation is higher than the genotypic coefficient of variation for all the traits.

Genotypic coefficient of variation (GCV) and phenotypic coefficients of variation (PCV) are categorized as low (10%), moderate (10-20%) and high (>20%) as suggested by Sivasubramanian and Madhavamenon (1973).

2013/DOL PVAR-1

2013/DOL PVAR-3

IS - 1

IS -2

IS -3

IS -4

IS -5

IS -6

IS -7

Plate-1 (2013/DOLPVAR-1 to IS -7) Depicting variability for inflorescence pattern, flower colour, pod size as well as plant

IS -8

IS -9

IS -10

IS -11

IS -12

IS -13

IS -14

IS -15

IS -16

Plate-2 (IS -8 to IS -16) Depicting variability for inflorescence pattern, flower colour, pod size as well as plant type.

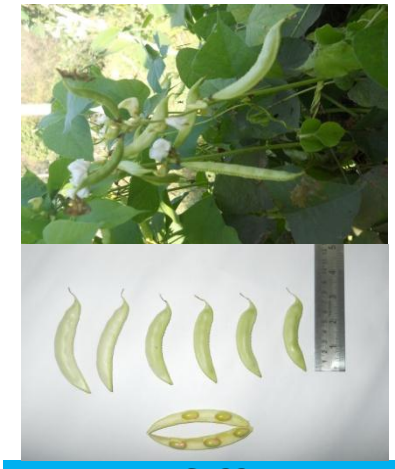
IS -17

IS -18

IS -19

IS -20

IS -21



IS -22

IS -23

IS -24

IS -25

Plate-3 (IS -17 to IS -25) Depicting variability for inflorescence pattern, flower colour, pod size as well as plant type.

IS -26

IS -27

IS -28

IS -29

IS -30

IS -31

IS -32

IS -33

IS -34

Plate-4 (IS -26 to IS -34) Depicting variability for inflorescence pattern, flower colour, pod size as well as plant type.

IS -35

IS -36

IS -37

IS -38

IS -39

IS -40

IS -41

IS -42

IS -43

Plate-5 (IS -35 to IS -43) Depicting variability for inflorescence pattern, flower colour, pod size as well as plant type.

IS -44

IS -45

IS -46

IS -47

IS -48

IS -49

IS -50

IS -51

IS -52

Plate-6 (IS -44 to IS -52) Depicting variability for inflorescence pattern, flower colour, pod size as well as plant type.

IS – 53

IS -54

IS -55

IS – 56

IS -57

IS -58

IS – 59

IS -60

IS -61

Plate-7 (IS -53 to IS -61) Depicting variability for inflorescence pattern, flower colour, pod size as well as plant type.

IS – 62

IS -63

IS -64

IS – 65

IS -66

IS -67

IS – 68

IS -69

IS -70

Plate-8 (IS -62 to IS -70) Depicting variability for inflorescence pattern, flower colour, pod size as well as plant type.

IS – 71

IS -72

IS -73

IS – 77

IS -79

IS -80

IS – 81

IS -83

IS -86

Plate-9 (IS -71 to IS -86) Depicting variability for inflorescence pattern, flower colour, pod size as well as plant type.

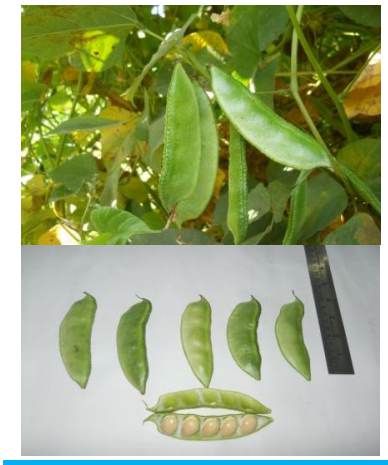
IS – 87

IS -88

IS -89

IS – 90

IS -91



IS -92

IS – 96

IS -97

IS -98

Plate-10 (IS -87 to IS -98) Depicting variability for inflorescence pattern, flower colour, pod size as well as plant type.

IS – 99

IS -100

IS -101

IS – 102

IS -103

IS -104

IS – 105-1

IS -105-2

IS -105-3

Plate-11 (IS -99 to IS -105-3) Depicting variability for inflorescence pattern, flower colour, pod size as well as plant

PUSA EARLY PROLIFIC

PUSA EARLY PROLIFIC

Plate-12 (PUSA EARLY PROLIFIC) Depicting variability for inflorescence pattern, flower colour, pod size as well as plant type.

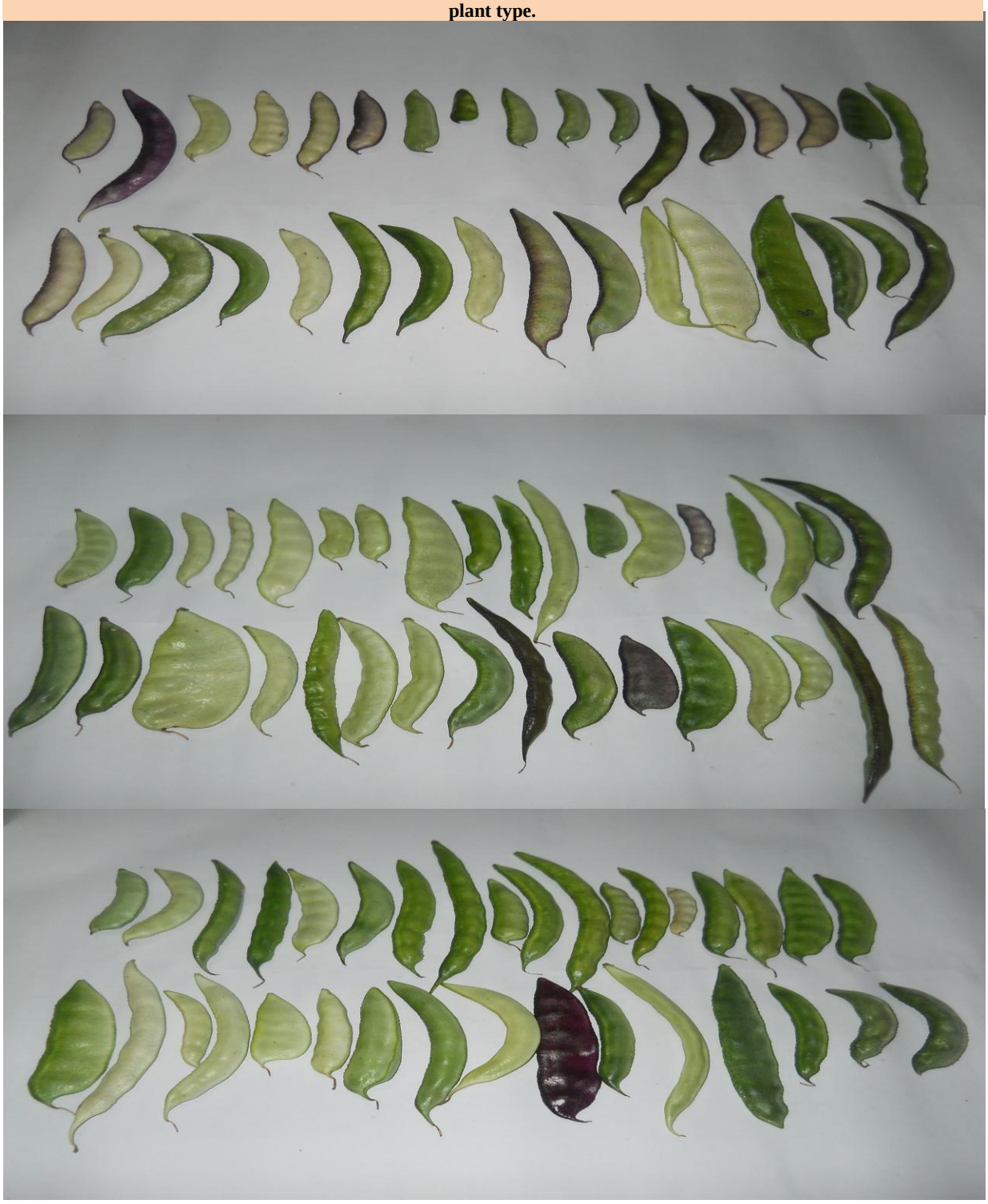


Plate-13 (IS -1 to IS -105-3) Showing pod variability in Dolichos bean

Genotypic and phenotypic coefficients of variation of different characters are presented in table 4.3 and table 4.4.

The highest value of genotypic coefficient of variation (GCV) was recorded for number of pods per plant (35.17%) followed by inflorescence length (32.34%), 10 pod weight (31.96%). pod length (28.02%), number of pod per inflorescence (27.38%), number of flower per inflorescence (27.30%), green pod yield per plant (22.39%) whereas, moderate genotypic coefficient of variation was recorded for 100 seed weight (19.74%), days to first flowering (12.54%), number of green pod picking (12.21%), pod width (11.85%), days to 50% flowering (11.60%), days to first pod harvest (10.66%) and lowest genotypic coefficient of variation was recorded for number of seeds per pod (9.23%), pedicel length (9.04%) and days to last pod harvest (5%).

The magnitude of phenotypic coefficient of variation was higher than the corresponding genotypic coefficient of variation for most of the characters. This might be due to the interaction of the genotypes with the environment to some degree or environmental factors influencing the expression of these characters. Similar result was also observed by Venkatesan *et al.* (2003) who reported that relative magnitude of phenotypic coefficient of variation is greater than corresponding genotypic coefficient of variation which indicates the effect of environment and by Upadhyay (2008) who studied the parameters of variation in 32 genotypes of dolichos bean and estimates of genetic parameters for various characters revealed that relative magnitude of phenotypic coefficient of variation was higher than genotypic coefficient of variation.

Hence, there is an ample scope for improvement of these traits. The results are general agreement with the findings of, Pandita *et al.* (1980) who also worked out the

Table 4.3 Genetic parameter of variation for green pod yield and its components in Dolichos bean.

S. No.	Parameters → / Characters ↓	Mean	Range		Coefficient of variation (%)		h^2 (bs) (%)	Genetic advance as per cent of mean
			Minimum	Maximum	Genotypic	Phenotypic		
1.	**Days to first flowering**	97.21	045.00 (IS-32)	116.00 (IS-31)	12.54	12.67	97.9	25.56
2.	**Days to 50% flowering**	104.67	051.33 (IS-21)	123.33 (IS-70)	11.60	11.76	97.3	23.57
3.	**Inflorescence length (cm.)**	17.45	004.15 (IS-37)	026.93 (IS-48)	32.34	32.92	96.5	65.50
4.	**No. of flower /Inflorescence**	20.57	008.93 (IS-37)	035.87 (IS-48)	27.30	27.76	96.7	55.28
5.	**No. of pods /Inflorescence**	06.12	002.60 (IS-72)	010.63 (IS-27)	27.38	28.38	93.1	54.41
6.	**Pedicel length (cm)**	0.25	000.19 (IS-79)	000.33 (IS-2 & IS-104)	09.04	11.82	58.6	16.00
7.	**Pod length (cm)**	9.98	004.41 (IS-8)	017.40 (2013-DOLPVAR -3)	28.02	28.20	98.7	57.42
8.	**Pod width (cm)**	02.01	001.49 (IS-87)	002.74 (IS-30)	11.85	12.70	87.1	22.89
9.	**No. of seed / Pod**	04.83	003.60 (IS-64)	006.20 (IS-77)	09.23	09.79	88.8	17.81
10.	**10 Pod weight (g)**	68.84	030.67 (IS-8)	148.33 (IS-30)	31.96	32.32	97.8	65.29
11	**Number of pods /plant**	31.50	011.67 (2013/DOL PVAR-3)	075.67 (IS-1)	35.17	36.09	95.0	70.60
12	**No. of green pod picking**	07.36	006.00 (IS-13, IS-15, IS-31 & IS-52)	012.00 (IS-32)	12.21	13.88	77.4	22.15
13	**Green pod yield/plant (g)**	199.33	118.67 (2013/DOL PVAR-3)	276.67 (IS-14)	22.39	22.82	96.3	45.27
14	**100 seed weight (g)**	37.73	023.33 (IS-51)	053.67 (IS-38)	19.74	20.09	96.6	39.97
15	**Days to first pod harvest**	111.88	058.00 (IS-32)	129.67 (IS-31)	10.66	10.80	97.3	21.65
16	**Days to last pod harvest**	188.52	149.33 (IS-36)	208.33 (IS-4)	05.00	05.33	87.8	09.64

Table 4.4 Summary of genotypic and phenotypic coefficient of variation with heritability and genetic advance as per cent of mean for green pod yield and its components in Dolichos bean.

S. No	Characters	GCV (%)	PCV (%)	h^2 (bs) (%)	Genetic advance as % of mean
1.	Days to first flowering	M	M	H	H
2.	Days to 50% flowering	M	M	H	H
3.	Inflorescence length (cm)	H	H	H	H
4.	Number of flower per Inflorescence	H	H	H	H
5.	Number of pod per Inflorescence	H	H	H	H
6.	Pedicel length (cm)	L	M	M	M
7.	Pod length (cm)	H	H	H	H
8.	Pod width (cm)	M	M	H	H
9.	Number of seeds per pod	L	L	H	M
10.	10 Pod weight(g)	H	H	H	H
11.	Number of pod per plant	H	H	H	H
12.	Number of green pod picking	M	M	H	H
13.	Green pod yield per plant (g)	H	H	H	H
14.	100 seed weight (g)	M	H	H	H
15.	Days to first pod harvest	M	M	H	H
16.	Days to 50% pod harvest	L	L	H	L

genetic variability in 26 varieties of *Dolichos lablab.* A wide range of variability was observed in most of the characters. The highest coefficient of genetic variation was observed for number of flowers per plant. Rao (1981) reported similar result for inflorescence length, pod per inflorescence in field bean and Patel (2010) also observed similar result for number of pod per plant and green pod yield per plant.

4.3.2 Heritability and genetic advance

Heritability estimate provides the information regarding the amount of transmissible genetic variation to total variation and determines genetic improvement and response to selection. In this study, heritability estimates have been made in broad sense for dolichos bean.

Genetic advance denotes the improvement in the genotypic value of the new population compared to the original population. Thus, the estimates of heritability and genetic advance are of great significance to the vegetable breeders for developing suitable selection strategy. Heritability and genetic advance are the important genetic parameters for selecting a genotype that permit greater effectiveness of selection by separating out environmental influence from total variability. However, it is not necessary that a character showing high heritability will also exhibit high genetic advance.

Heritability and genetic advance estimated for different characters under study are presented in table 4.3 and table 4.4.

The highest heritability estimate was observed for pod length (98.7%) followed by, days to first flowering (97.9%), 10 pod weight (97.8%), days to 50% flowering (97.3%), days to first pod harvest (97.3%), number of flower per inflorescence (96.7%), 100 seed weight (96.6%), inflorescence length (96.5%), green pod yield / plant (96.3%), number of pods per plant (95%), number of pod per inflorescence

(93.1%), number of seeds per pod (88.8%), days to last pod harvest (87.8%), pod width (87.1%), number of green pod picking (77.4%). While moderate heritability estimates is being recorded in pedicel length (58.6%).

On other hand highest genetic advance as percent of mean was observed for number of pods per plant (70.60) followed by inflorescence length (65.50), 10 pod weight (65.29), pod length (57.42), number of flower per inflorescence (55.28), number of pod per inflorescence (54.41), green pod yield per plant (45.27), 100 seed weight (39.97), days to first flowering (25.56), days to 50% flowering (23.57), pod width (22.89), number of green pod picking (22.15), days to first pod harvest (21.65) whereas, moderate genetic advance was recorded for number of seeds per pod (17.81) and pedicel length (16). Lowest genetic advance was recorded for days to last pod harvest (9.64).

Higher heritability estimates coupled with high genetic advance as percent of mean were observed for days to first flowering, days to 50% flowering, inflorescence length, number of flower per inflorescence, number of pods per inflorescence, pod length, pod width, 10 pod weight, number of pod per plant, number of green pod picking, green pod yield per plant, 100 seed weight and days to first pod harvest. These characters indicated the role of additive genetic variance towards expression of available characters. Higher heritability coupled with moderate and low genetic advance as percentage of mean, was observed for number of seeds per pod and days to last pod harvest respectively and moderate heritability coupled with moderate genetic advance as percentage of mean, was observed for pedicel length which may be due to the role of non-additive genetic component in their expression.

Over all observations of genetic variability analysis revealed that direct selection of days to first flowering, days to 50% flowering, inflorescence length,

number of flower per inflorescence, number of pods per inflorescence, pod length, pod width, 10 pod weight, number of pod per plant, number of green pod picking, green pod yield per plant, 100 seed weight and days to first pod harvest may be advantageous in developing desirable dolichos bean genotypes for Chhattisgarh plains.

These findings are in general agreement with the findings of Patel (2010) who reported the similar result for inflorescence length, number of flower per inflorescence and number of pod per inflorescence and Upadhyay (2008) also found the similar result for number of pod per inflorescence, pod width and pod weight.

The result of present investigation are in general agreement with the result of Wahabuddin and Bhalla (1986) and Venkatesan *et al*. (2003) for no. of pods per plant and Upadhyay (2008) for number of pod per inflorescence.

4.4 Correlation coefficient analysis

Association analysis gives an idea about relationship among the various characters and determines the component characters, on which selection can be used for genetic improvement in the fruit yield. The yield components may not always be independent in their nature but may be interlinked. The degree of association between independent and dependent variables was first suggested by Galton (1888), its theory was developed by Pearson (1904) and their mathematical utilization at phenotypic, genotypic and environmental levels was described by Searle (1961).

The phenotypic correlations were normally of genetic and environmental interaction which provided information about the association between the two characters. Genotypic correlation provided a measure of genetic association between the characters and normally used in selection while, environmental as well as genetic architecture of a genotype plays a great role in achieving higher yield combined with

Table 4.5 Correlation coefficient of green pod yield and its components in Dolichos bean

S. No.	Characters		Days to first flower-ing	Days to 50% flower-ing	Inflorescence length (cm.)	No. of flower per Inflorescence	No. of pods per Inflorescence	Pedicl length (cm)	Pod length (cm)	Pod width (cm)	No. of seeds per Pod	10Pod weight (g)	Number of pods per plant	No. of green pod picking	100 seed weight (g)	Days to first pod harvest	Days to last pod harvest	Green pod yield per Plant (g)
1	**Days to first flowering**	P	1.000	0.989**	-0.207*	-0.177	-0.169	-0.143	0.015	0.064	0.096	0.015	0.106	-0.544**	0.312**	0.969**	0.615**	0.171
		G	1.000	0.996**	-0.212*	-0.183	-0.175	-0.184	0.016	0.072	0.102	0.014	0.112	-0.626**	0.320**	0.982**	0.650**	0.183
2	**Days to 50% flowering**	P		1.000	-0.224*	-0.182	-0.177	-0.161	0.020	0.056	0.093	0.018	0.088	-0.557**	0.298**	0.970**	0.606**	0.155
		G		1.000	-0.228*	-0.188	-0.183	0.206*	0.022	0.057	0.098	0.018	0.093	-0.643**	0.308**	0.981**	0.636**	0.166
3	**Inflorescence length (cm.)**	P			1.000	0.871**	0.502**	0.057	-0.116	-0.190	-0.116	-0.244*	0.301**	0.193	-0.189	-0.227*	-0.077	0.123
		G			1.000	0.893**	0.530**	0.061	-0.121	-0.203*	-0.116	-0.251*	0.320**	0.209*	-0.195	-0.233*	0.092	0.133
4	**No. of flower per Inflorescence**	P				1.000	0.421**	-0.023	-0.074	-0.162	-0.064	-0.169	0.197	0.142	-0.147	-0.180	-0.101	0.066
		G				1.000	0.436**	-0.032	-0.075	-0.176	-0.072	-0.178	0.213*	0.156	-0.151	-0.183	-0.105	0.071
5	**No. of pods per Inflorescence**	P					1.000	0.002	-0.134	-0.070	-0.071	-0.209*	0.366**	0.143	-0.244*	-0.169	-0.062	0.179
		G					1.000	-0.012	-0.134	-0.71	-0.081	-0.215*	0.391**	0.141	-0.251*	-0.175	-0.079	0.195
6	**Pedicel length (cm)**	P						1.000	0.356**	0.040	0.201*	0.242*	-0.156	0.146	0.050	-0.148	-0.001	0.108
		G						1.000	0.469**	0.031	0.273**	0.306**	-0.189	0.220*	0.072	-0.190	-0.006	0.156
7	**Pod length (cm)**	P							1.000	0.078	0.677**	0.709**	-0.486**	-0.014	0.453**	0.030	0.040	0.202*
		G							1.000	0.082	0.721**	0.715**	-0.497**	-0.011	0.463**	0.032	0.043	0.207*
8	**Pod width (cm)**	P								1.000	-0.018	0.377**	-0.265**	-0.027	0.281**	0.067	0.046	0.031
		G								1.000	-0.026	0.411**	-0.294**	-0.014	0.307**	0.072	0.049	0.036
9	**No. of seeds per Pod**	P									1.000	0.479**	-0.311**	0.021	0.380**	0.087	0.126	0.254*
		G									1.000	0.509**	-0.338**	0.013	0.414**	0.092	0.142	0.269**
10	**10 Pod weight (g)**	P										1.000	-0.709**	-0.042	0.530**	0.037	-0.014	0.190
		G										1.000	-0.717**	-0.053	0.544**	0.040	-0.015	0.198*
11	**Number of pods per Plant**	P											1.000	0.083	-0.241*	0.100	0.235*	0.455**
		G											1.000	0.105	-0.257	0.103	0.260**	0.449**
12	**No. of green pod picking**	P												1.000	-0.129	-0.559**	0.220*	0.061
		G												1.000	-0.136	-0.637**	0.163	0.084
13	**100 seed weight (g)**	P													1.000	0.357**	0.298**	0.358**
		G													1.000	0.371**	0.328**	0.367**
14	**Days to first pod harvest**	P														1.000	0.635**	0.205*
		G														1.000	0.659**	0.217*
15	**Days to last pod harvest**	P															1.000	0.331**
		G															1.000	0.373**
16	**Green pod yield per Plant (g)**	P																1.000
		G																1.000

* Significant at 5%, ** Significant at 1%, P=Phenotypic; G=Genotypic

better quality.

The low phenotypic correlation could result due to masking influence and modifying effect of the environment on the association of characters. Gritton (1986) have pointed out that no suitable test of significance of genetic correlation is available. Therefore, their primary utility is in strengthening interpretations based on phenotypic correlation and in better predicting correlated responses to selection. Hence, important findings based on both phenotypic and genotypic correlation are discussed here to clear the picture of correlation of different characters.

As correlation coefficients are the index of association between two variables; these have been worked out in all possible combinations at phenotypic (P) and genotypic (G) levels and are given in table 4.5.

Experimental findings of correlation analysis revealed that green pod yield per plant expressed a highly significant positive correlation with number of pods per plant and 100 seed weight at phenotypic and genotypic level and it also showed significant positive correlation with days to last pod harvest and days to first pod harvest at phenotypic and genotypic level. Green pod yield per plant also showed significant positive correlation with pod length and number of seeds per pod at phenotypic and genotypic level and 10 pod weight exhibited the significant positive correlation with green pod yield per plant at genotypic level.

Days to first flowering had positive and significant correlation with days to 50% flowering, 100 seed weight, days to first pod harvest and days to last pod harvest at phenotypic and genotypic levels whereas, it had negatively significant correlation with inflorescence length and number of green pod picking at both phenotypic and genotypic levels.

Days to 50% flowering exhibited significant positive correlation with 100 seed weight, days to first pod harvest and days to last pod harvest at phenotypic and genotypic levels whereas, pedicel length at genotypic levels only. Days to first flowering had also negatively significant correlation with inflorescence length and number of green pod picking at both phenotypic and genotypic levels.

Inflorescence length had significant positive correlation with number of flower per inflorescence, number of pod per inflorescence and number of pod per plant at phenotypic and genotypic levels and with number of green pod picking at genotypic level only whereas, it had negatively significant correlation with 10 pod weight and day to first pod harvest at both phenotypic and genotypic levels and with pod width at genotypic level only.

Number of flower per inflorescence had significant positive correlation with number of pod per inflorescence at both phenotypic and genotypic levels and with number of pods per plant at genotypic level only.

Number of pod per inflorescence had significant positive correlation with number of pods per plant at both phenotypic and genotypic levels and it had negatively significant correlation with 10 pod weight and 100 seed weight at both phenotypic and genotypic levels.

Pedicel length had significant positive correlation with pod length, number of seeds per pod and 10 pod weight at both phenotypic and genotypic levels and with number of green pod picking at genotypic level only.

Pod length had significant positive correlation with number of seeds per pod, 10 pod weight and 100 seed weight at both phenotypic and genotypic levels and it had negatively significant correlation with number of pod per plant at both phenotypic and genotypic levels.

Pod width had significant positive correlation with 10 pod weight and 100 seed weight at both phenotypic and genotypic levels whereas, it had negatively significant correlation with number of pod per plant at both phenotypic and genotypic levels.

Number of seeds per pod had significant positive correlation with 10 pod weight and 100 seed weight at both phenotypic and genotypic levels whereas, it had negatively significant correlation with number of pod per plant at both phenotypic and genotypic levels.

10 pod weight had significant positive correlation with 100 seed weight at both phenotypic and genotypic levels whereas, it had negatively significant correlation with number of pods per plant at both phenotypic and genotypic levels.

Number of pods per plant had significant positive correlation with days to last pod harvest at both phenotypic and genotypic levels. It had negatively significant correlation with 100 seed weight at phenotypic level only.

Number of green pod picking had significant positive correlation with days to last pod harvest at phenotypic level only and it had negatively significant correlation with days to first pod harvest at phenotypic and genotypic level.

100 seed weight had significant positive correlation with days to first pod harvest and days to last pod harvest at both phenotypic and genotypic levels.

Days to first pod harvest had significant positive correlation with days to last pod harvest at both phenotypic and genotypic levels.

An overall observation of correlation coefficient analysis revealed that pod length, number of seeds per pod, number of pods per plant, 100 seed weight, days to first pod harvest and days to last pod harvest exhibited the positive correlation with green pod yield per plant at both genetic and phenotypic levels and 10 pod weight

exhibited the positive correlation with green pod yield per plant at genotypic level. Hence, direct selection for these traits may lead to the development of high green pod yielding in dolichos genotypes. Similarly inflorescence length, number of pod per inflorescence and number of pod per plant also exhibits the positive correlation with number of flower per inflorescence. Hence, direct selection for these traits may lead to the development of high yielding genotypes of dolichos bean.

Similar result was observed by Patel (2010) for number of pod per inflorescence and number of pod harvest. Uddin and Newaz (1997) also observed similar result for number of flower per inflorescence and number of pod per inflorescence.

The experimental findings on correlation coefficient analysis are in general agreement with the result reported by Baswana *et al.* (1980), Pandita *et al.* (1980), Pandey *et al*. (1980) and Dahiya *et al.* (1991) and Upadhyay (2008).

4.5 Path coefficient analysis

Path coefficient analysis is an important tool for partitioning the correlation coefficients into the direct and indirect effects of independent variables on a dependent variable with the inclusion of more variables in correlation study.

Their indirect association becomes more complex. Two characters may show correlation, just because they are correlated with a common third one. In such circumstances, path coefficient analysis provides an effective means of a critical examination of specific forces action to produce a given correlation and measure the relative importance of each factor.

Path coefficient analysis can explain the extent of relative contribution. In this analysis, fruit yield per plant was taken as dependent variable and the rest of the characters were considered as independable variables.

Table 4.6 Genotypic path coefficient characters in Dolichos bean

Characters	Days to first flowering	Days to 50% flowering	Inflorescence length (cm.)	No. of flower / Inflorescence	No. of pods / Inflorescence	Pedicel length (cm)	Pod length (cm)	Pod width (cm)	No. of seed / Pod	10 Pod weight (g)	Number of pods /plant	No. of green pod picking	100 seed weigh (g)	Days to first pod harvest	Days to last pod harvest	Green pod yield/ Plant (g)
Days to first flowering	**-1.066**	0.344	-0.028	0.008	0.014	-0.014	-0.003	0.001	0.025	0.014	0.130	0.388	0.025	-0.090	0.435	0.183
Days to 50% flowering	-1.061	**0.345**	-0.030	0.009	0.015	-0.016	-0.004	0.001	0.024	0.017	0.107	0.399	0.024	-0.090	0.425	0.166
Inflorescence length (cm.)	0.226	-0.079	**0.131**	-0.040	-0.044	0.005	0.020	-0.004	-0.029	-0.237	0.368	-0.130	-0.015	0.021	-0.062	0.133
No. of flower / Inflorescence	0.195	-0.065	0.117	**-0.045**	-0.036	-0.003	0.013	-0.003	-0.018	-0.167	0.245	-0.096	-0.012	0.017	-0.070	0.071
No. of pods / Inflorescence	0.186	-0.063	0.069	-0.020	**-0.083**	-0.001	0.022	-0.001	-0.020	-0.203	0.450	-0.088	-0.019	0.016	-0.053	0.195
Pedicel length (cm)	0.196	-0.071	0.008	0.001	0.001	**0.078**	-0.079	0.001	0.068	0.228	-0.218	-0.136	0.006	0.017	-0.004	0.156
Pod length (cm)	-0.017	0.007	-0.016	0.003	0.011	0.037	**-0.168**	0.001	0.179	0.673	-0.573	0.007	0.036	-0.003	0.029	0.207
Pod width (cm)	-0.077	0.020	-0.027	0.008	0.006	0.002	-0.014	**0.018**	-0.006	0.387	-0.339	0.009	0.024	-0.007	0.033	0.036
No. of seed / Pod	-0.108	0.034	-0.015	0.003	0.007	0.021	-0.121	0.000	**0.248**	0.479	-0.389	-0.008	0.032	-0.008	0.095	0.269
10 Pod weight(g)	-0.015	0.006	-0.033	0.008	0.018	0.024	-0.120	0.007	0.126	**0.942**	-0.826	0.033	0.042	-0.004	-0.010	0.198
Number of pods /plant	-0.120	0.032	0.042	-0.010	-0.032	-0.015	0.084	-0.005	-0.184	-0.675	**1.153**	-0.065	-0.020	-0.009	0.174	0.449
No. of green pod picking	0.667	-0.222	0.027	-0.007	-0.012	0.017	0.002	0.000	0.003	-0.050	0.121	**-0.620**	-0.011	0.058	0.109	0.084
100 seed weight (g)	-0.341	0.106	-0.026	0.007	0.021	0.006	-0.078	0.005	0.103	0.513	-0.296	0.084	**0.078**	-0.034	0.219	0.367
Days to first pod harvest	-1.047	0.339	-0.031	0.008	0.014	-0.015	-0.005	0.001	0.023	0.038	0.118	0.395	0.029	**-0.091**	0.440	0.217
Days to last pod harvest	-0.693	0.219	-0.012	0.005	0.006	-0.001	-0.007	0.001	0.035	-0.014	0.300	-0.101	0.025	-0.060	**0.668**	0.373

Residual value: 0.1855 Diagonal and bold underline figures shows direct effect on pod yield

The path coefficient analysis which splits total correlation coefficient of different characters into direct and indirect effects on fruit yield per plant in such a manner that the sum of direct and indirect effects is equal to total genotypic correlation as presented in table 4.6.

The data revealed that number of pods per plant (1.153) expressed a highest positive direct effect on green pod yield per plant followed by 10 pod weight (0.942), days to last pod harvest (0.668), days to 50% flowering (0.345), number of seeds per pod (0.248), inflorescence length (0.131), pedicel length (0.078), 100 seed weight (0.078), pod width (0.018). While days to first flowering (-1.066), number of green pod picking (-0.620), pod length (-0.168), days to first pod harvest (-0.091), number of pods per inflorescence (-0.083), and number of flower per inflorescence (-0.045) showed negative direct effects on green pod yield per plant.

Days to first flowering showed positive indirect effect on green pod yield per plant through days to last pod harvest (0.435), number of green pod picking (0.388), days to 50% flowering (0.344), number of pods per plant (0.130), number of seeds per pod (0.025), 100 seed weight (0.025), number of pod per inflorescence (0.014), 10 pod weight (0.014), number of flower per inflorescence (0.008), and pod width (0.001) while rest of the characters exhibited indirect negative values.

Days to 50% flowering showed positive indirect effect on green pod yield per plant through days to last pod harvest (0.425), number of green pod picking (0.399), number of pods per plant (0.107), number of seeds per pod (0.024), 100 seed weight (0.024), 10 pod weight (0.017), number of pod per inflorescence (0.015), number of flower per inflorescence (0.009) and pod width (0.001) while rest of the characters exhibited indirect negative values.

Inflorescence length showed positive indirect effect on green pod yield per plant through number of pods per plant (0.368), days to first flowering (0.226), days to first pod harvest (0.021), pod length (0.020) and pedicel length (0.005) while rest of the characters exhibited indirect negative values.

Number of flower per inflorescence showed positive indirect effect on green pod yield per plant through number of pod per plant (0.245), days to first flowering (0.195), inflorescence length (0.117), days to first pod harvest (0.017) and pod length (0.013) while rest of the characters exhibited indirect negative values.

Number of pod per plant showed positive indirect effect on pod yield per plant through number of pod per plant (0.450), days to first flowering (0.186), inflorescence length (0.069), pod length (0.022), and days to first pod harvest (0.016) while rest of the characters exhibited indirect negative values.

Pedicel length showed positive indirect effect on green pod yield per plant through 10 pod weight (0.228), days to first flowering (0.196), number of seeds per pod (0.068), days to first pod harvest (0.017) inflorescence length (0.008), 100 seed weight (0.006) number of flower per inflorescence (0.001), number of pod per inflorescence (0.001) and pod width (0.001) while rest of the characters exhibited indirect negative values.

Pod length showed positive indirect effect on green pod yield per plant through 10 pod weight (0.673), number of seed per pod (0.179), pedicel length (0.037), 100 seed weight (0.036), days to last pod harvest (0.029), number of pods per plant (0.011), days to 50% flowering (0.007), number of green pod picking (0.007), number of flower per inflorescence (0.003), and pod width (0.001) while rest of the characters exhibited indirect negative values.

Pod width showed positive indirect effect on green pod yield per plant through 10 pod weight (0.387), days to last pod harvest (0.033), 100 seed weight (0.024), days to 50% flowering (0.020), number of green pod picking (0.009), number of flower per inflorescence (0.008), number of pods per plant (0.006) and pedicel length (0.002) while rest of the characters exhibited indirect negative values.

Number of seed per pod showed positive indirect effect on green pod yield per plant through 10 pod weight (0.479), days to last pod harvest (0.095), days to 50% flowering (0.034), 100 seed weight (0.032), pedicel length (0.021), number of pods per plant (0.007), number of flower per inflorescence (0.003), and pod width (0.00) while rest of the characters exhibited indirect negative values.

10 pod weight showed positive indirect effect on green pod yield per plant through 100 seed weight (0.42), number of seed per pod (0.126), number of green pod picking (0.033), pedicel length (0.024), number of pods per plant (0.018), number of flower per inflorescence (0.008), pod width (0.007) and days to 50% flowering (0.006) while rest of the characters exhibited indirect negative values.

Number of pods per plant showed positive indirect effect on green pod yield per plant through days to last pod harvest (0.174), pod length (0.084), inflorescence length (0.042) and days to 50% flowering (0.032) while rest of the characters exhibited indirect negative values.

Number of green pod picking showed positive indirect effect on green pod yield per plant through days to first flowering (0.667), number of pods per plant (0.121), days to last pod harvest (109), days to first pod harvest (0.058), inflorescence length (0.027), pedicel length (0.017), number of seed per pod (0.003), pod length (0.002), and pod width (0.000) while rest of the characters exhibited indirect negative values.

100 seed weight showed positive indirect effect on green pod yield per plant through 10 pod weight (0.513), days to last pod harvest (0.219), days to 50% flowering (0.106), number of seed per pod (0.103), number of green pod picking (0.084), number of pod per inflorescence (0.021), number of flower per inflorescence (0.007), pedicel length (0.006) and pod width (0.005) while rest of the characters exhibited indirect negative values.

Days to first pod harvest showed positive indirect effect on green pod yield per plant through days to last pod harvest (0.440), number of green pod picking (0.395), days to 50% flowering (0.339), number of pods per plant (0.118), 10 pod weight (0.038), 100 seed weight (0.024), number of seed per pod (0.023), number of pod per inflorescence (0.014), number of flower per inflorescence (0.008) and pod width (0.001) while rest of the characters exhibited indirect negative values.

Days to last pod harvest showed positive indirect effect on green pod yield per plant through number of pods per plant (0.300), days to 50% flowering (0.219), number of seed per pod (0.035), 100 seed weight (0.025), number of pod per inflorescence (0.006), number of flower per inflorescence (0.005) and pod width (0.001) while rest of the characters exhibited indirect negative values.

The effect of residual factor (0.1855) on fruit yield per plant was negligible, thereby, suggested that no other major yield component is left over.

In present investigation, number of pod per plant showed high positive and direct effect had significant positive correlation with green pod yield per plant. Therefore, number of pod per plant should be considered in selection criteria for increasing green pod yield per plant. The present study suggested that more emphasis should be given to selecting genotypes with more number of pods per plant and 10 pod weight.

The experimental findings on path analysis are in general agreement with the result reported by Patel (2010) who observed similar result for number of pods per plant with green pod yield per plant. Rao (1981) also reported that pods per plant showed highest direct effect on seed yield per plant at both genotypic and phenotypic levels. Dahiya *et al*. (1991) also worked on dolichos bean and revealed that selection based on number of pods per plant and pod weight will be more effective for the improvement of yield.

4.6 Genetic divergence analysis

The concept of D^2 statistics was originally developed by Mahalonobis (1936). Then Rao (1952) suggested the application of this technique for the arrangement of genetic diversity in plant breeding. Now, this technique is being extensively used in vegetable breeding to study the selection of different parents. The problem of selection may further be simplified if one could identify the characters responsible for discrimination between parents. Literatures available on this aspect in dolichos bean are rather scanty. Therefore, the present investigation was aimed at ascertaining the nature and magnitude of genetic diversity among a set of dolichos bean genotypes.

Dolichos bean is a predominantly autogamous crop and no information is available suggesting a change in its breeding behaviour under varied environmental conditions. Therefore successful hybridization programme is a difficult task for a vegetable breeder.

4.6.1 Cluster analysis

On the basis of D^2 analysis, hundred genotypes were grouped into five clusters (Table 4.7). Maximum number of genotypes *i.e*. 27 were grouped into cluster II (IS-8, IS-13, IS-15, IS-16, IS-19, IS-35, IS-44, IS-46, IS-47, IS-49, IS-52, IS-55, IS-57, IS-61, IS-67, IS-73, IS-79, IS-87, IS-88, IS-97, IS-99, IS-100, IS-101, IS-101-

Table 4.7 Clustering pattern of Dolichos bean genotype on the basis of Mahalanobis D^2 statistics

Cluster Number	Number of genotypes included	Genotypes
I	19	IS-23, IS-24, IS-29, IS-30, IS-33, IS-34, IS-37, IS-41, IS-45, IS-50, IS-53, IS-69, IS-70, IS-71, IS-72, IS-89, IS-90, IS-91, IS-102.
II	27	IS-8, IS-13, IS-15, IS-16, IS-19, IS-35, IS-44, IS-46, IS-47, IS-49, IS-52, IS-55, IS-57, IS-61, IS-67, IS-73, IS-79, IS-87, IS-88, IS-97, IS-99, IS-100, IS-101, IS-101-1, IS-105-2, IS-105-3, 2013/DOL PVAR-1
III	22	IS-1, IS-3, IS-4, IS-5, IS-6, IS-7, IS-9, IS-10, IS-11, IS-14, IS-18, IS-20, IS-22, IS-25, IS-28, IS-31, IS-39, IS-40, IS-54, IS-64, IS-83, IS-86.
IV	25	IS-2, IS-12, IS-17, IS-26, IS-27, IS-38, IS-42, IS-43, IS-48, IS-56, IS-60, IS-62, IS-63, IS-65, IS-66, IS-68, IS-77, IS-80, IS-81, IS-92, IS-96, IS-98, IS-103, IS-104, 2013/DOL PVAR-3.
V	7	IS-21, IS-32, IS-36, IS-51, IS-58, IS-59, Pusa Early Prolific.

Table 4.8 Average Inter and Intra cluster distance values in Dolichos bean (*Lablab purpureus* L.)

Cluster Number	I	II	III	IV	V
I	**2.991**	3.680	4.589	3.493	7.997
II		**2.655**	2.805	3.592	6.279
III			**2.618**	3.569	7.323
IV				**3.033**	6.757
V					**3.807**

1, IS-105-2, IS-105-3, 2013/DOL PVAR-1) followed by cluster IV having 25 genotypes (IS-2, IS-12, IS-17, IS-26, IS-27, IS-38, IS-42, IS-43, IS-48, IS-56, IS-60, IS-62, IS-63, IS-65, IS-66, IS-68, IS-77, IS-80, IS-81, IS-92, IS-96, IS-98, IS-103, IS-104, 2013/DOL PVAR-3), cluster III having 22 genotypes (IS-1, IS-3, IS-4, IS-5, IS-6, IS-7, IS-9, IS-10, IS-11, IS-14, IS-18, IS-20, IS-22, IS-25, IS-28, IS-31, IS-39, IS-40, IS-54, IS-64, IS-83, IS-86), cluster I having 19 genotypes (IS-23, IS-24, IS-29, IS-30, IS-33, IS-34, IS-37, IS-41, IS-45, IS-50, IS-53, IS-69, IS-70, IS-71, IS-72, IS-89, IS-90, IS-91, IS-102) and cluster V having 7 genotypes (IS-21, IS-32, IS-36, IS-51, IS-58, IS-59, Pusa Early Prolific).

It is vivid from the Table 4.8 that maximum inter cluster distance was observed between cluster I and V (7.997) which was followed by cluster III and V (7.323), cluster IV and V (6.757), cluster II and V (6.279), cluster I and III (4.589), cluster I and II (3.680), cluster II and IV (3.592), cluster III and IV (3.569), cluster I and IV (3.493) and cluster II and III (2.805).

Highest intra cluster distance was recorded for cluster V (3.807) followed by cluster IV (3.033), cluster I (2.991), cluster II (2.655) and cluster III showed minimum intra cluster distance (2.618).

4.6.2 Mean performance of clusters

The mean performance for different clusters of genotypes for green pod yield and its components are presented in (Table 4.9). The data of cluster means for all the characters showed appreciable differences.

The cluster mean performance for days to first flowering was highest in cluster I (103.04 days), which was followed by cluster III (102.32 days), cluster IV (98.31 days), cluster II (97.57 days) and lowest for cluster V (60.00 days). Whereas, the cluster mean performance for days to 50% flowering was highest in cluster I (110.67

Table 4.9 Mean performance of different clusters for Green Pod yield and its component traits

Characters / Clusters	Days to first flowering	Days to 50% flowering	Inflore-scence length (cm.)	No. of flower / Inflore -scence	No. of pods / Inflore -scence	Pedicel length (cm)	Pod length (cm)	Pod width (cm)	No. of seed / Pod	10 Pod weight (g)	No. of pods /plant	No. of green pod picking	Green pod yield/ Plant (g)	100 seed weight (g)	Days to first pod harvest	Days to last pod harvest
I	103.04	110.67	8.12	12.01	4.82	0.25	11.26	2.12	5.01	83.86	24.88	7.05	196.75	42.74	118.11	191.75
II	97.57	105.11	17.54	20.82	5.65	0.24	8.02	1.98	4.54	55.79	30.81	7.00	163.83	33.59	111.69	183.96
III	102.32	109.26	21.11	22.66	7.37	0.25	8.00	1.96	4.63	52.48	46.14	7.35	236.05	35.44	116.47	193.94
IV	98.31	106.05	20.36	24.21	6.22	0.27	12.90	2.02	5.17	86.72	25.92	7.49	217.40	42.32	113.64	191.65
V	60.00	67.33	20.55	23.32	7.18	0.26	9.90	1.97	4.83	66.00	26.00	9.14	163.33	30.86	75.00	169.14

days), which was followed by cluster III (109.26 days), cluster IV (106.05 days), cluster II (105.11 days) and lowest for cluster V (67.33 days).

The highest cluster mean value for inflorescence length was recorded by cluster III (21.11 cm) which was followed by cluster V (20.55 cm), cluster IV (20.26 cm), cluster II (17.54 cm), and cluster I (8.12 cm). While number of flower per inflorescence recorded the highest cluster mean performance in cluster IV (24.21) which was followed by cluster V (23.32), cluster III (22.66), cluster II (20.82), and cluster I (12.01).

The highest cluster mean value for number of pod per inflorescence was recorded by cluster III (7.37) which was followed by cluster V (7.18), cluster IV (6.22), cluster II (5.65), and cluster I (4.82). While the cluster mean performance for pedicel length was highest in cluster IV (0.27 cm) which was followed by cluster V (0.26 cm), cluster III and I (0.25 cm) and lowest for cluster II (0.24 cm). The highest pod length was recorded in cluster IV (12.90 cm) followed by cluster I (11.26 cm), cluster V (9.90 cm), cluster II (8.02 cm) and cluster III (8.00 cm). The highest cluster mean value for pod width was recorded by cluster I (2.12 cm) followed by cluster IV (2.02 cm), cluster II (1.98 cm), cluster V (1.97 cm), and cluster III (1.96 cm).

Number of seed per pod showed the highest mean performance for cluster IV (5.17), which was followed by cluster I (5.01), cluster V (4.83), cluster III (4.63) and cluster II (4.54). While the highest cluster mean value for 10 pod weight was recorded by cluster IV (86.72 g) followed by cluster I (83.86 g), cluster V (66 g), cluster II (55.79 g), and cluster III (52.48 g). The highest cluster mean value for number of pods per plant was recorded by cluster III (46.14) followed by cluster II (30.81), cluster V (26), cluster IV (25.92), and cluster I (24.88).

Green pod picking showed the highest mean performance for cluster V (9.14) followed by cluster IV (7.49), cluster III (7.35), cluster I (7.05), and cluster II (7.00). Green pod yield per plant recorded the highest mean performance for cluster III (236.05 g) followed by cluster IV (217.40 g), cluster I (196.75 g), cluster II (163.83 g), and cluster V (163.33 g). The highest cluster mean value for 100 seed weight was recorded by cluster I (42.74 g) followed by cluster IV (42.32 g), cluster III (35.44 g), cluster II (33.59 g), and cluster V (30.86 g).

The cluster mean performance for days to first pod harvest was highest in cluster I (118.11 days), which was followed by cluster III (116.47 days), cluster IV (113.64 days), cluster II (111.69 days) and lowest for cluster V (75.00 days). Whereas, the cluster mean performance for days to last pod harvest was highest in cluster III (193.94 days), which was followed by cluster I (191.75 days), cluster IV (191.65 days), cluster II (183.96 days) and lowest for cluster V (169.14 days).

Thus, while planning hybridization programme for the development of better transgressive segregants one should select genotypes IS-23, IS-24, IS-29, IS-30, IS-33, IS-34, IS-37, IS-41, IS-45, IS-50, IS-53, IS-69, IS-70, IS-71, IS-72, IS-89, IS-90, IS-91and IS-102 for earliest days to first flowering, days to 50% flowering, maximum pod width, 100 seed weight and days to first pod harvest from cluster I. Whereas, genotypes IS-1, IS-3, IS-4, IS-5, IS-6, IS-7, IS-9, IS-10, IS-11, IS-14, IS-18, IS-20, IS-22, IS-25, IS-28, IS-31, IS-39, IS-40, IS-54, IS-64, IS-83 and IS-86 for maximum inflorescence length, number of pod per inflorescence, number of pod per plant, green pod yield per plant and days to last pod harvest from cluster III. Maximum number of flower per inflorescence, pedicel length, pod length, number of seed per pod and 10 pod weight from cluster IV and green pod picking per plant from cluster V.

These results are in general agreement with the findings of Baswana *et al.* (1980), Nandi *et al.* (2000), Borah and Khan (2001) Vineeta (2004) and Golani *et al.* (2006) and Upadhayay (2008).

In this study, group constellation showed that cluster III (IS-1, IS-3, IS-4, IS-5, IS-6, IS-7, IS-9, IS-10, IS-11, IS-14, IS-18, IS-20, IS-22, IS-25, IS-28, IS-31, IS-39, IS-40, IS-54, IS-64, IS-83, IS-86) were highly divergent from all other genotypes and may be used as parents in breeding programme and may directly be used as a pure line variety for green pod yield and quality characters in dolichos bean (*Lablab purpureus* L.) for Chhattisgarh state and country as well.

Summary, Conclusion And Suggestions For Future Research Work

CHAPTER-V

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FUTURE RESEARCH WORK

The present investigation entitled **"Variability, association and genetic divergence analysis in Dolichos bean (*Lablab purpureus* L.)"** was conducted at Horticultural Research cum Instructional Farm of Department of Horticulture, under All India Coordinated Research Project on Vegetable Crops, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during *kharif* to *Rabi* season of 2013-14. The experiment comprised of hundred genotypes of dolichos bean (*Lablab purpureus* L.) and laid out in Randomized Block Design (RBD) with three replications to estimate the genetic variability, heritability, genetic advance, correlation coefficient, path coefficient analysis and genetic divergence.

Five randomly selected plants were considered for observations of different characters *viz*., days to first flowering, days to 50 % flowering, inflorescence length (cm), number of flower per inflorescence, pedicel length (cm), number of pod per inflorescence , pod length (cm), pod width (cm), number of pod per plant, number of seed per pod, hundred seeds weight (g), 10 pod weight (g), and yield per plant (g).

The analysis of variance indicated that the mean sum of square due to genotypes were significantly influenced by all the traits and indicated presence of sufficient amount of variability among the genotypes for green pod yield and its components traits.

The highest green pod yield per plant was recorded in genotype IS-14 (276.67 g) followed by IS-11 (274.67 g), IS-02 (272.67 g), and IS-18 (271 g). The earliest flowering was recorded at IS-32 (45 days) which was followed by IS-21 (46.67 days)

and IS-36 (62.67 days). The earliest 50% flowering was recorded at IS-21 (51.33 days) which was followed by IS-32 (52.33 days) and IS-36 (71.33 days). Highest length of inflorescence was recorded in IS-48 (26.93 cm) followed by IS-02 (26.21 cm), and IS-01 (25.05 cm). Number of flower per inflorescence ranged from 8.93 to 35.87. Number of flower per inflorescence was recorded maximum in IS-48 (35.87) which was followed by IS-79 (30.70) and IS-38 (30.47). Number of pods per inflorescence ranged from 2.60 to 10.63. Maximum number of pod per inflorescence was recorded in IS-27(10.63) which was followed by IS-01(10.13) and IS-40 (9.93). Maximum pedicel length recorded in IS-2 and IS-104 (0.33cm) which was followed by IS-105-1(0.32 cm) and IS-21, IS-77 and 2013/DOL PVAR-3 (0.31 cm). Maximum pod length was recorded in 2013/DOL PVAR-3 (17.40cm) followed by IS-43 (16.90 cm), IS-96 (16.56 cm), and IS-33 (16.11 cm). Maximum pod width was recorded in IS-30 (2.74 cm) followed by IS-72 (2.62 cm) and IS-104 (2.60 cm). Maximum number of pod per plant was counted in IS-01 (75.67) which was followed by IS-18 (57.67), IS-04 (55.33) and IS-64 (54.33). Maximum number of green pod picking was recorded in IS-32 (12) which was followed by IS-21 (11.33), IS-51 (10) and IS-58 (9). Maximum 10 pod weight was recorded in IS-30 (148.33 g) which was followed by IS-53 (115 g), IS-50 (112 g) and IS-65 (108.33 g). Maximum green pod yield per plant was recorded in IS-14 (276.67 g) which was followed by IS-11 (274.67 g), IS-2 (272.67 g) and IS-18 (271 g). The first pod harvest was recorded in IS-32 which was 58 days after sowing followed by IS-21 (62.33 days), IS-51 (78.33days), and Pusa Early Prolific (79 days). The early last pod harvest days were recorded in IS-36 (149.33 days) after sowing which was followed by IS-105-3 (170 days), IS-58 (173.33 days) and 2013/DOL PVAR-3 (174 days). Maximum number of seeds per

pod was counted in IS-77 (6.20) which was followed by IS-81 (6.07) and IS-17(5.87). 100 seed weight recorded maximum for IS-38 (53.67 g) which was followed by IS-04 (53 g), IS-24 (52.33 g), IS-41 and IS-59 (52 g).

The present findings showed that considerable variability existed among the genotypes for most of the traits showing possibilities of further genetic improvement of dolichos bean.

The highest value of genotypic coefficient of variation (GCV) was recorded for number of pods per plant (35.17%) followed by inflorescence length (32.34%), 10 pod weight (31.96%). pod length (28.02%), number of pod per inflorescence (27.38%), number of flower per inflorescence (27.30%), green pod yield per plant (22.39%) whereas, moderate genotypic coefficient of variation was recorded for 100 seed weight (19.74%), days to first flowering (12.54%), number of green pod picking (12.21%), pod width (11.85%), days to 50% flowering (11.60%), days to first pod harvest (10.66%) and lowest genotypic coefficient of variation was recorded for number of seeds per pod (9.23%), pedicel length (9.04%) and days to last pod harvest (5%).

The highest heritability estimate was observed for pod length (98.7%) followed by, days to first flowering (97.9%), 10 pod weight (97.8%), days to 50% flowering (97.3%), days to first pod harvest (97.3%), number of flower per inflorescence (96.7%), 100 seed weight (96.6%), inflorescence length (96.5%), green pod yield / plant (96.3%), number of pods per plant (95%), number of pod per inflorescence (93.1%), number of seeds per pod (88.8%), days to last pod harvest (87.8%), pod width (87.1%), number of green pod picking (77.4%). While moderate heritability estimates is being recorded in pedicel length (58.6%).

On other hand highest genetic advance as percent of mean was observed for number of pods per plant (70.60) followed by inflorescence length (65.50), 10 pod weight (65.29), pod length (57.42), number of flower per inflorescence (55.28), number of pod per inflorescence (54.41), green pod yield per plant (45.27), 100 seed weight (39.97), days to first flowering (25.56), days to 50% flowering (23.57), pod width (22.89), number of green pod picking (22.15), days to first pod harvest (21.65) whereas, moderate genetic advance was recorded for number of seeds per pod (17.81) and pedicel length (16). Lowest genetic advance was recorded for days to last pod harvest (9.64).

Higher heritability estimates coupled with high genetic advance as percent of mean were observed for days to first flowering, days to 50% flowering, inflorescence length, number of flower per inflorescence, number of pods per inflorescence, pod length, pod width, 10 pod weight, number of pod per plant, number of green pod picking, green pod yield per plant, 100 seed weight and days to first pod harvest. These characters indicated the role of additive genetic variance towards expression of available characters. Higher heritability coupled with moderate and low genetic advance as percentage of mean, was observed for number of seeds per pod and days to last pod harvest respectively and moderate heritability coupled with moderate genetic advance as percentage of mean, was observed for pedicel length which may be due to the role of non-additive genetic component in their expression.

An overall observation of correlation coefficient analysis revealed that pod length, number of seeds per pod number of pods per plant, 100 seed weight, days to first pod harvest and days to last pod harvest exhibited the positive correlation with green pod yield per plant at both genetic and phenotypic levels and 10 pod weight exhibited the positive correlation with green pod yield per plant at genotypic level.

Hence, direct selection for these traits may lead to the development of high green pod yielding in dolichos genotypes. Similarly inflorescence length, number of pod per inflorescence and number of pod per plant also exhibits the positive correlation with number of flower per inflorescence. Hence, direct selection for these traits may lead to the development of high yielding genotypes of dolichos bean.

The data revealed that number of pods per plant (1.153) expressed a highest positive direct effect on green pod yield per plant followed by 10 pod weight (0.942), days to last pod harvest (0.668), days to 50% flowering (0.345), number of seeds per pod (0.248), inflorescence length (0.131), pedicel length (0.078), 100 seed weight (0.078), pod width (0.018). While days to first flowering (-1.066), number of green pod picking (-0.620), pod length (-0.168), days to first pod harvest (-0.091), number of pods per inflorescence (-0.083), and number of flower per inflorescence (-0.045) showed negative direct effects of green pod yield per plant.

D^2 values recorded on green pod yield per plant and its components for hundred genotypes, indicated the presence of appreciable amount of genetic diversity among the genotypes, which were grouped into five clusters based on relative magnitude of D^2 values.

Thus, while planning hybridization programme for the development of better transgressive segregants one should select genotypes IS-23, IS-24, IS-29, IS-30, IS-33, IS-34, IS-37, IS-41, IS-45, IS-50, IS-53, IS-69, IS-70, IS-71, IS-72, IS-89, IS-90, IS-91and IS-102 for earliest days to first flowering, days to 50% flowering, maximum pod width, 100 seed weight and days to first pod harvest from cluster I. Whereas, genotypes IS-1, IS-3, IS-4, IS-5, IS-6, IS-7, IS-9, IS-10, IS-11, IS-14, IS-18, IS-20,

IS-22, IS-25, IS-28, IS-31, IS-39, IS-40, IS-54, IS-64, IS-83 and IS-86 for maximum inflorescence length, number of pod per inflorescence, number of pod per plant, green pod yield per plant and days to last pod harvest from cluster III. Maximum number of flower per inflorescence, pedicel length, pod length, number of seed per pod and 10 pod weight from cluster IV and green pod picking per plant from cluster V.

Conclusion

The analysis of variance findings showed that considerable variability existed among the genotypes for most of the traits showing possibilities of further genetic improvement, of Indian bean.

The mean performance for green pod yield per plant (g), of IS-14 was superior among all the genotypes. The variability studies revealed that the high genotypic and phenotypic coefficient of variation were recorded for number of pods per plant followed by inflorescence length, 10 pod weight pod length, number of pod per inflorescence, number of flower per inflorescence, green pod yield per plant. Higher heritability estimates coupled with high genetic advance as percent of mean were observed for days to first flowering, days to 50% flowering, inflorescence length, number of flower per inflorescence, number of pods per inflorescence, pod length, pod width, 10 pod weight, number of pod per plant, number of green pod picking, green pod yield per plant, 100 seed weight and days to first pod harvest. Correlation studies revealed that marketable green pod yield per plant (g) showed the highest positive and significant correlation with number of pods per plant, hundred seed weight (g), days to last pod harvest and number of seed per pod. Number of pods per plant showed highest positive and direct effect on green pod yield per plant.

Therefore, number of pod per plant should be considered in selection criteria for increasing green pod yield per plant.

The D^2 values recorded for hundred genotypes indicated the presence of appreciable amount of genetic diversity among the genotypes. In this study, group constellation showed that cluster III (IS-1, IS-3, IS-4, IS-5, IS-6, IS-7, IS-9, IS-10, IS-11, IS-14, IS-18, IS-20, IS-22, IS-25, IS-28, IS-31, IS-39, IS-40, IS-54, IS-64, IS-83, IS-86) were highly divergent from all other genotypes and may be used as parents in hybrid breeding programme and may directly be used as a pure line variety for green pod yield and quality characters in dolichos bean (*Lablab purpureus* L.)

Suggestions for future research work

On the basis of experience gained and results obtained after completion of the present investigation, following suggestions may be given to conduct further research:

1. Large number of genotypes may be collected from different untouched places of Chhattisgarh and should be evaluated to measure the magnitude of genetic variability available in this crop.
2. Selection criteria that have been formulated may be used in the selection of desirable high yielding genotypes and early flowering dolichos bean.
3. There is need to screen the genotypes against biotic stresses (disease and insect pest) particularly yellow mosaic, anthracnose, aphid and pod borer.
4. The experiment should be repeated over the year to confirm the findings.
5. All the genotypes should be tested in different environment of Chhattisgarh and at national level as well.

Abstract

'VARIABILITY, ASSOCIATION AND GENETIC DIVERGENCE ANALYSIS IN DOLICHOS BEAN (*Lablab purpureus* L.)"

By
KU. SAVITA PATEL

ABSTRACT

The present investigation was carried out at Department of Horticulture, under All India Coordinated Research Project on Vegetable Crops, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during *Kharif* to *Rabi* season of 2013-14. The experimental material comprised of hundred genotypes of dolichos bean and the experiment was laid out in randomised block design with three replications.

The mean performance for earliest days to first flowering, days to first pod harvest and maximum number of green pod picking was recorded in IS-32. Earliest days to 50% flowering was recorded in IS-21. Maximum pod length and number of seed per pod was recorded in 2013/DOL PVAR-3 and IS-77 respectively. Maximum pod width and 10 pod weight was recorded in IS-30 and maximum number of pod per plant was recorded in IS-1. Maximum 100 seed weight and earliest days to last pod harvest was recorded in IS-38 and IS-36 respectively. Marketable green pod yield per plant were recorded highest for IS-14.

High genotypic and phenotypic coefficient of variation were recorded for number of pods per plant followed by inflorescence length (cm), 10 pod weight (g), pod length (cm), number of pod per inflorescence, number of flower per inflorescence and green pod yield per plant (g). It was also revealed that relative magnitude of phenotypic coefficient of variation was higher than the genotypic coefficient of variation under the study.

Correlation and path analysis studies revealed that marketable green pod yield per plant (g) showed the highest positive and significant correlation with number of pods per plant, hundred seed weight (g), days to last pod harvest and number of seed per pod. Number of pods per plant showed highest positive and direct effect on green pod yield per plant. Therefore, number of pod per plant should be considered in selection criteria for increasing green pod yield per plant.

The divergence analysis revealed the presence of appreciable amount of genetic diversity in the tested genotypes. Hundred genotypes were grouped into five clusters. Cluster II had highest no. of genotypes (27) followed by cluster IV (25), cluster III (22) cluster I (19) and lowest in cluster V (7).

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*Original not seen.

Appendices

Appendix-I Weekly meteorological data during the crop period (July 24, 2013 to February 17, 2014)

Months and year	Standard Week No.	Temperature (^{0}C)		Rainfall (mm)	Relative Humidity (%)		Wind velocity (kmph)	Evaporation (mm)	Sun shine (Hours)
		Max.	Min.		I	II			
July,2013	27	31.3	24.5	73.5	90	70	6.7	4. 7	4.4
	28	31.2	24.3	144.4	93	78	7.7	4.3	3.9
	29	30.5	25.3	44.6	95	74	6.4	2.9	2.3
	30	28.4	24.7	88.2	92	83	9	2.1	0.7
	31	28.3	23.9	255.8	95	84	7.4	2.7	1.3
Aug.,2013	32	31.1	24.7	87.4	93	76	5.2	3.6	3.3
	33	31.3	24.3	177	95	80	3.2	3.2	3.3
	34	27.9	23.8	60.5	92	84	9.3	2.1	1.5
	35	29.3	24.5	120.8	95	80	5.8	2.8	3.1
Sept.,2013	36	31.1	24.8	54.8	93	76	3	4	4.2
	37	31.9	25.2	11.6	92	73	2	3.6	6.2
	38	29.9	24.1	92.6	93	77	3.7	2.8	2.5
	39	32	24.9	28.6	93	68	2.7	4	6.3
Oct.,2013	40	30.1	24.1	45.2	95	75	3.6	3	4.2
	41	30.2	23.3	8.6	89	71	4.6	3.4	3.5
	42	30.7	21.4	0	91	56	2	3.5	8.6
	43	28.8	22.6	32.6	96	73	3.9	2.7	2.1
	44	30.5	17.3	0	92	38	0.7	3.5	8.9
Nov.,2013	45	29.9	16.6	0	91	37	0.6	3.1	8.2
	46	27.5	13.2	0	91	36	1	2.8	7.6
	47	30.3	16.7	0	87	40	1.5	3.2	7.3
	48	30	15.6	0	83	35	1.6	3.5	7.3
Dec.,2013	49	28.1	11.8	0	91	31	1.3	3.1	8.5
	50	27.7	9.8	0	90	27	1.3	3	9
	51	28.1	11.7	0	90	34	1.6	2.6	8
	52	28.3	12.7	0	93	40	0.9	2.6	6.5
Jan.,2014	1	28.6	13.6	0	90	40	0.7	2.6	6.9
	2	27.8	14.1	0	90	47	1.6	2.5	5.4
	3	29	16.1	0	89	46	2.5	2.8	4.6
	4	28.2	13.7	0	87	38	2.4	3.6	7
	5	28.8	10.2	0	86	28	2.1	3.7	9.5
Feb.,2014	6	31.7	14.8	0	85	33	3.2	4.3	8.7
	7	27.9	15.4	45.8	83	39	4.1	4.3	6.6
	8	28.9	14.6	18.6	86	41	2.9	4.1	8.7
	9	27.9	17.7	45.8	91	61	4.1	4.1	6.6

Appendix-II Quality characters observed in Dolichos bean genotype

S.No.	Genotype	Plant growth habit	Pod Colour	Pod length shape	Pod width shape
1.	IS-1	Pole	Purple	Curved	Intermediate
2.	IS-2	Pole	Purple	Curved	Round
3.	IS-3	Pole	White	Curved	Intermediate
4.	IS-4	Pole	Light Green	Curved	Round
5.	IS-5	Pole	Purple	Curved	Round
6.	IS-6	Pole	Purple	Curved	Intermediate
7.	IS-7	Pole	Light Green	Curved	Intermediate
8.	IS-8	Pole	Green	Straight	Flat
9.	IS-9	Pole	Light Green	Curved	Intermediate
10.	IS-10	Pole	Light Green	Curved	Intermediate
11.	IS-11	Pole	Light Green	Curved	Round
12.	IS-12	Pole	Purple	Curved	Intermediate
13.	IS-13	Pole	Purple	Curved	Round
14.	IS-14	Pole	Purple	Curved	Round
15.	IS-15	Pole	Purple	Curved	Intermediate
16.	IS-16	Pole	Dark Green	Straight	Flat
17.	IS-17	Pole	Dark Green	Curved	Round
18.	IS-18	Pole	Purple	Curved	Round
19.	IS-19	Pole	Light Green	Curved	Round
20.	IS-20	Bush	Dark Green	Curved	Flat
21.	IS-21	Bush	Dark Green	Curved	Flat
22.	IS-22	Pole	White	Curved	Round
23.	IS-23	Pole	Dark Green	Curved	Round
24.	IS-24	Pole	Dark Green	Curved	Flat
25.	IS-25	Pole	White	Curved	Flat
26.	IS-26	Pole	Purple	Curved	Round
27.	IS-27	Pole	Purple	Curved	Flat
28.	IS-28	Pole	White	Curved	Round
29.	IS-29	Pole	White	Curved	Flat
30.	IS-30	Pole	Dark Green	Curved	Flat
31.	IS-31	Pole	Dark Green	Curved	Round
32.	IS-32	Bush	Dark Green	Curved	Round
33.	IS-33	Pole	Purple	Curved	Intermediate
34.	IS-34	Pole	White	Curved	Round
35.	IS-35	Pole	Dark Green	Curved	Round
36.	IS-36	Pole	White	Curved	Round
37.	IS-37	Pole	White	Curved	Round
38.	IS-38	Pole	White	Curved	Flat
39.	IS-39	Pole	Light Green	Curved	Intermediate
40.	IS-40	Pole	Light Green	Curved	Intermediate
41.	IS-41	Pole	White	Curved	Flat
42.	IS-42	Pole	Dark Green	Curved	Round
43.	IS-43	Pole	White	Curved	Round
44.	IS-44	Pole	Dark Green	Curved	Flat
45.	IS-45	Pole	White	Curved	Flat
46.	IS-46	Pole	Purple	Curved	Intermediate
47.	IS-47	Pole	Dark Green	Curved	Round
48.	IS-48	Pole	White	Curved	Round
49.	IS-49	Pole	Light Green	Straight	Intermediate

50.	IS-50	Pole	Purple	Curved	Round
51.	IS-51	Bush	Dark Green	Curved	Flat
52.	IS-52	Pole	Dark Green	Curved	Flat
53.	IS-53	Pole	Creamish	Curved	Flat
54.	IS-54	Pole	Light Green	Straight	Intermediate
55.	IS-55	Pole	Dark Green	Curved	Round
56.	IS-56	Pole	White	Curved	Flat
57.	IS-57	Pole	White	Curved	Flat
58.	IS-58	Pole	Dark Green	Curved	Flat
59.	IS-59	Pole	Purple	Curved	Round
60.	IS-60	Pole	Dark Green	Curved	Flat
61.	IS-61	Pole	Purple	Straight	Flat
62.	IS-62	Pole	Dark Green	Curved	Flat
63.	IS-63	Pole	White	Curved	Round
64.	IS-64	Pole	White	Curved	Round
65.	IS-65	Pole	Purple	Curved	Round
66.	IS-66	Pole	Light Green	Curved	Round
67.	IS-67	Pole	Green	Straight	Round
68.	IS-68	Pole	White	Curved	Round
69.	IS-69	Pole	Light Green	Curved	Round
70.	IS-70	Pole	Dark Green	Curved	Round
71.	IS-71	Pole	White	Straight	Flat
72.	IS-72	Pole	Green	Curved	Round
73.	IS-73	Pole	Green	Straight	Round
74.	IS-77	Pole	Dark Green	Curved	Round
75.	IS-79	Pole	Light Green	Straight	Round
76.	IS-80	Pole	Green	Straight	Round
77.	IS-81	Pole	Light Green	Straight	Round
78.	IS-83	Pole	Light Green	Straight	Round
79.	IS-86	Pole	Dark Green	Curved	Round
80.	IS-87	Pole	White	Straight	Round
81.	IS-88	Pole	Light Green	Straight	Round
82.	IS-89	Pole	Green	Straight	Round
83.	IS-90	Pole	Green	Straight	Flat
84.	IS-91	Pole	Dark Green	Curved	Round
85.	IS-92	Pole	Green	Straight	Flat
86.	IS-96	Pole	White	Straight	Round
87.	IS-97	Pole	White	Curved	Round
88.	IS-98	Pole	White	Curved	Round
89.	IS-99	Pole	White	Straight	Flat
90.	IS-100	Pole	White	Straight	Round
91.	IS-101	Pole	Light Green	Straight	Round
92.	IS-102	Pole	Green	Straight	Round
93.	IS-103	Pole	White	Straight	Flat
94.	IS-104	Pole	Purple	Straight	Flat
95.	IS-105-1	Bush	Light Green	Curved	Round
96.	IS-105-2	Bush	Light Green	Curved	Flat
97.	IS-105-3	Bush	Light Green	Curved	Round
98.	2013DOLPVAR-1	Pole	Light Green	Straight	Round
99.	2013DOLPVAR-3	Pole	Light Green	Straight	Flat
100.	Pusa Early Prolific	Pole	Light Green	Straight	Round