PERFORMANCE ANALYSIS OF BUSH LABLAB BEAN (*Lablab purpureus* (L.) SWEET)

By

SREEKANTH K. S.

THESIS

Submitted in partial fulfilment of the
requirement for the degree of

Master of Science in Horticulture

Faculty of Agriculture
Kerala Agricultural University

Department of Olericulture

COLLEGE OF HORTICULTURE
VELLANIKKARA, THRISSUR - 680 656
KERALA, INDIA

2007

DECLARATION

I, hereby declare that this thesis entitled "Performance analysis of bush lablab bean (*Lablab purpureus* (L.) Sweet)" is a bonafide record of research work done by me during the course of research and that it has not been previously formed the basis for the award to me of any degree, diploma, fellowship or other similar title, of any other University or Society.

Vellanikkara
28-9-07

Sreekanth K S

CERTIFICATE

Certified that this thesis entitled "Performance analysis of bush lablab bean (*Lablab purpureus* (L.) Sweet)" is a bonafide record of research work done independently by **Mr. Sreekanth K S** under my guidance and supervision and that it has not formed the basis for the award of any degree, diploma, fellowship or associateship to him.

Vellanikkara
28.9.2007

Dr. Baby Lissy Markose
(Major Advisor, Advisory Committee)
Professor
Department of Olericulture
College of Horticulture
Vellanikkara

CERTIFICATE

We, the undersigned members of the Advisory Committee of **Mr. Sreekanth. K.S** a candidate for the degree of **Master of Science in Horticulture** with major in **Olericulture,** agree that this thesis entitled **"Performance analysis of bush lablab bean (*Lablab purpureus* (L.) Sweet)"** may be submitted by **Mr. Sreekanth. K.S** in partial fulfilment of the requirement for the degree.

28/9/07

Dr. Baby Lissy Markose

Professor
Department of Olericulture
College of Horticulture
Vellanikkara
Chairperson, Advisory Committee

28/9/07

Dr.T.E. George

Professor and Head
Department of Olericulture
College of Horticulture
Vellanikkara.

(Member, Advisory Committee)

28/9/07

Dr. Salikutty Joseph

Professor
Department of Olericulture
College of Horticulture
Vellanikkara.

(Member, Advisory Committee)

28/9/07

Dr. V.V. Radhakrishnan
Professor and Head
Department of Plant Breeding and Genetics
College of Horticulture
Vellanikkara
(Member, Advisory Committee)

28/9/07

EXTERNAL EXAMINER

ACKNOWLEDGEMENT

It is great respect and devotion. I place on record my deep sense of gratitude and indebtness to my major advisor **Dr. Baby Lissy Markose** *Professor, Department of Olericulture and chairperson of my advisory committee, for her sustained and valuable guidance, constructive suggestions, unfailing patience, motherly affection, constant support and encouragement during the conduct of this research work and preparation of the thesis. I gratefully remember her knowledge and wisdom which nurtured this research project in right direction without which this would have been a futile excercise. I really consider it my fortune in having her guidance for the thesis work.*

It is my pleasant privilege to oblige **Dr. T. E. George**, *Professor and Head, Department of Olericulture, College of Horticulture, Vellanikkara and member of my advisory committee, for his ardent interest, valuable suggestions, critical scrutiny of the manuscript and ever willing help which has helped a lot for the refinement of this work.*

No words can truly represent my profound gratitude and indebtedness to **Dr. Salikutty Joseph** *Professor Department of Olericulture, College of Horticulture, Vellanikkara and member of my advisory committee for her expert counsel, invaluable guidance, untiring interest, patient hearing, constructive suggestions, esteemed advise and immense help rendered through out the course of this investigation.*

I place a deep sense of obligation to **Dr. V.V. Radhakrishnan** *Professor and Head, Department of Plant breeding and genetics, College of Horticulture and member of my Advisory Committee for the help and co-operation received from him during the entire programme. He in spite of a busy schedule has offered constructive suggestions for the betterment of this manuscript.*

I convey my heart felt thanks to **Sri S. Krishnan**, *Assistant Professor, Department of Agricultural Statistics, for his keen interest, valuable suggestions, and immense help rendered in the statistical analysis of data*

I am extremely grateful to **Dr. K.P. Prasanna** *Associate Professor, Department of Olericulture for her valuable help in taking photographs.*

I express my deep sense of gratitude to ***Dr. P.G. Sadan kumar, Dr. K.V. Suresh babu, Dr. p. Indira., Dr. K. Krishna kumari and Dr. S. Nirmaladevi*** *of department of Olericulture for their friendly help and whole hearted support.*

Words cannot really express the true friendship that I relished from ***Anish, Naveen, Ravinra, Praveen, & Kishore*** *and my UG friends* ***Uday, Chetan, Rama, Manju, Lokesh & Raju,*** *who rendered immense help, timely advice and full hearted support during the course of work.*

I am thankful to my friend ***Rathish, S.T.*** *for the pains he has taken to computerize my thesis photos with meticulous care.*

I wish to express my sincere gratitude to senior friends ***Shankar,*** *Sharon, and Vishnu for their wholehearted support.*

A special note of thanks is due to my dearest friends ***Vinesh,*** *Shareesh, Liffey, Remya, Nidhi, Kavya, Hazmin, Nisha, Riya and Hima. I am greatful to all my junior friends* ***Deviprasad, Madhu, Jagadish,*** *Harsha, Puttaswamy, Manikantan, Dinesh, Alok, Rahul, & Thiagarajan and my UG juniors* ***Harish and Punith*** *for their timely and thoughtful help during the course of study.*

A special note of thanks is also due to ***Lalitha chechi, Santha chechi, Kunjaman cheta*** *and all the nonteaching staff of Department of Olericulture for all the helps rendered by them and courtesies extended in the proper conduct of my research work.*

The award of KAU Junior Fellowship is thankfully acknowledged.

Above all, the moral support, constant encouragement, affectionate concern of ***my Parents, Brothers and their family*** *motivated me to complete this endeavour successfully. I am in dearth of words to express my strong emotions and gratitude to them.*

A word of apology to those I have not mentioned in person and a note of thanks to one and all who helped in the successful completion of this endeavour.

Sreekanth

Sreekanth, K.S.

Dedicated

To my parents, Brothers and their

Family

CONTENTS

LIST OF TABLES

LIST OF PLATES

Introduction

1. INTRODUCTION

Legumes are primarily herbaceous plants in temperate climate but can exist as trees and shrubs in tropical climates. The fruit of members of the Fabaceae is a flattened dehiscent pod called a legume. Many members of the family can assimilate their own source of nitrogen as a result of a symbiotic relationship with nitrogen fixing *Rhizobium* bacterial nodules in their roots. The edible legumes are an absolute necessity in the diet of the vegetarians or in countries where little meat is eaten. With an annual global production of 156 million metric tonnes, legumes rank third among the food crops, topped only by root and tuber crops and cereals (FAO, 1980).

Lablab bean, *Lablab purpureus* L. Sweet (2n= 20, 22, 24) belonging to the family Fabaceae is a native of India and is presently grown in both Sub-tropical and tropical conditions. Relatively cool season is favourable for growth and production. (Rai and Yadav, 2005). Lablab bean occupies a unique position for its use as vegetable and seed. Tender as well as shelled green pods are used as vegetable and dried seeds as pulse. Leaves are cooked and eaten like spinach. Foliage provides fodder and manure. The crop is highly effective for erosion control and soil protection. The following synonyms have been recorded for this bean.

1. ***Dolichos lablab*** **L. (Roxburgh, 1832)**
2. ***Dolichos purpureus*** **L. (Linnaeus, 1763)**
3. ***Lablab niger*****, Medik. (Medikus, 1787)**
4. ***Lablab vulgaris*** **Savi. (Savi, 1824)**
5. ***Lablab purpureus*** **(L) Sweet. (Sweet 1827)**

This is commonly referred to as lablab bean, dolichos bean, bonavist bean, Indian bean, hyacinth bean, sem (Hindi), avare (Kannada), avarai (Tamil) and amara (Malayalam).

Lablab bean is one of the major sources of protein in the dietary in southern India (Kathi, 2002). It is also a good source of minerals and vitamins. The Amino acid composition of Indian bean is comparable to other legume proteins and methionine is the most limiting one (Rai and Yadav, 2005).

Lablab bean is a common vegetable grown throughout the country and in an agriculture-based country like India, increasing crop productivity is the key stone for overall development. Among the major reasons that have sustained a huge population in our country, are the development of varieties with high production potential and the science based agrotechnology that expresses this potential optimally. Genetic improvement for higher production and better quality has been an effective tool, since the advent of scientific agriculture. Two components involved in crop improvement are creation of genetic variability and devicing methodologies for combining characteristics of different individuals into a superior cultivar.

A number of constraints limit lablab bean production. Apart from the obvious genetic inadequacies such as extreme viny growth habit, compulsive photoperiodism, low flowering and pod setting abilities and low yields, problems like susceptibility to insect pests, lack of resistance to viral, bacterial and fungal diseases, lack of tolerance to excessive moisture levels, weed infestation and inadequate soil nutrient supply are super imposing to its disadvantage. Commercial cultivation is limited because of its photosensitive nature. Very little variability is observed may be because of self-fertilization and usually grown in isolated locations such as backyards. Hence creation of variability is necessary to meet the varied consumer demand and crop improvement. Despite its high economic and nutritive values, high yielding varieties

of lablab bean with acceptable market quality and bushy habit are lacking. Bush type lablab bean does not require staking and thus reduces the cost of cultivation.

To overcome the above mentioned constraints, there is an urgent need to develop bush types which are early, high yielding, disease resistant and non- season bound (Peter, 1998). Regarding this, efforts have been made to bring about modifications in plant type (Shivashankar *et al.*, 1993) in which the viny types have been changed to bush types which facilitates increased plant population resulting in higher yields. Further, the duration has been cut down from 160 to 110 days which increases per day productivity, harvest index has been greatly enhanced and highly photosensitive nature has been converted into photoinsensitive nature which permits cultivation of this crop all round the year (Thamburaj and Singh, 2003).

Breeding methodology for crop improvement consists of two stages (1) Genetically cataloguing the available germplasm (2) studying the variability in yield and identifying the suitable line(s) for further breeding programme. For assessing superiority of genotypes, a sound knowledge of the nature and magnitude of variation in the available material, genetic parameters namely genetic advance, heritability, genetic divergence and association of different traits among themselves and with yield become imperative before embarking upon any major selection procedure in lablab bean. Hence the present study was undertaken with the following objectives.

1. Genetic cataloguing of germplasm based on the descriptor of lablab bean.

2. Estimating the phenotypic and genotypic coefficients of variation.

3. Assessing the genetic parameters, viz. heritability, genetic advance and genetic gain.

4. Estimating the direct and indirect effects of yield attributes on yield using path coefficient analysis.

5. Clustering the different accessions so as to quantify the genetic divergence among themselves.

6. Identifying the elite bush genotypes on the basis of selection indices.

7. Locating photo insensitive bush lablab bean types.

Review of literature

2. REVIEW OF LITERATURE

The crop improvement efforts are rather scanty in lablab bean in general and bush types in particular. However some improvement works such as selection for size, shape and colour of pods and seeds, maturity, yield and nutritional contents have been carried out in the last two decades. In lablab bean several workers are involved in the development of bushy types. The biometrical aspects of leguminous vegetables with special reference to lablab bean are reviewed here under.

1. Details of bushy lablab bean
2. Genetic variability
3. Heritability
4. Correlation
5. Path coefficient analysis
6. Genetic divergence
7. Selection index
8. Quality

2.1 Details of Bushy lablab bean

The available literature on various aspects of crop improvement in bush lablab bean is reviewed as follows.

Ramasamy *et al.* (1990) reported that the vegetable cultivar CO11, developed by crossing bush type cv. CO 9 with pandal type cv. WhiteYanaikathu, is very early maturing (95-100 days) and produces a green pod yield of 9.4 t/ha

(vs. 6.1 t/ha in CO 9). Pod quality of CO 11 is higher than that of CO 9. CO 11 was released for irrigated cultivation in Tamil Nadu in 1989. During 1990 the Institute Varietal Release Committee identified two high yielding varieties of lablab bean (*Lablab purpureus*), for release in the state of Karnataka, viz, Arka Jay and Arka Vijay (IIHR, 1991).

Evaluation of selected bush type vegetable cowpea varieties by Wahab *et al.* (1991) for earliness, vegetative and productive characters for three seasons have identified IIHR 61-B and Selection 2-1 as high yielding for summer and rainy seasons respectively under Kerala conditions.

Rajput *et al.* (1991) reported that, out of the four [*Lablab purpureus*] varieties compared during 1986-89, DPL-D-1 gave the highest yield and had the longest pods.

In a field trial with lablab bean var. IIHR selection-1 at different planting intensities conducted by Reddy *et al.* (1991) at Hyderabad, pod yield decreased from 8.97 to 3.13 t/ha with decrease in plant density. CGR decreased and RGR increased slightly with decrease in planting intensity.

In a field experiment conducted by Singh *et al.* (1992) at Barapani, Meghalaya, lablab bean cultivars Sel 1 and Sel 2, are given different levels of phosphorus (0, 8.73, 17.47, 26.2 and 34.93 kg P/ha) produced mean green pod yield which ranged from 2.62 to 12.0 t/ha. Sel 2 produced higher green pod yield than Sel 1 (8.20 vs. 7.11 t).

From the segregating population of Hebbal Avare 3 x Wall (Rajput *et al.*, 1994) high yielding vegetable type *Lablab purpureus* genotypes were selected. The Promising selection DPL-D1, named Konkan Bhushan, gave a greater pod yield than other popular varieties (8.8-13.6 vs. 5.0-9.3 t/ha). It is a bush type plant, 60-75 cm tall and matures 55-60 days after sowing.

In a field trial conducted by Desai *et al.* (1995) in rabi (winter) Konkan Bhushan was given 0, 50 or 100 kg N/ha, 0, 25 or 50 kg P_2O_5/ha and triacontanol at 25 kg granules/ha or 25 ppm NAA. Pod yield was the highest (9.27 t/ha) with a combination of 100 kg N and 50 kg P2O5. Application of triacontanol and NAA slightly increased yield.

In a field trial conducted by Jadhav *et al.* (1996) in summer 1991 at Rahuri, Maharashtra, *Lablab purpureus* cv. Konkan Bhushan pod yield was 640, 509 and 387 kg/ha when irrigated at 75, 100 and 150 mm cumulative pan evaporation, respectively, and 415, 569, 537 and 525 kg with 50, 100, 150 and 200 kg N/ha. Water use efficiency decreased with increasing irrigation and was the highest with 100 kg N/ha.

In a field experiment conducted by Kale *et al.* (1997) 1994/95 in Maharashtra, *Lablab purpureus* cv. Konkan Bushan was given 0-75 kg N and 0-150 kg P2O5/ha. The application of 75 kg N + 150 kg P2O5 produced the highest pod yield of 13.01 t/ha.

Saud and Bhorali (1998) evaluated 17 indigenous cultivars of *Lablab purpureus* for different quantitative and qualitative characters. Five cultivars were high yielding. Two cultivars, Sylheti Uri and Aswina Uri, showed better field resistance to biotic stresses than the other cultivars. In addition, Sylheti Uri and Aswina Uri are particularly recommended for breeding for earliness.

'Xiangbiandou 1' is an extremely early cultivar (Peng-YouLin *et al.*, 2001). Dense planting of this new cultivar produces high yield. The yield is about 42,000 kg/m^2 and is resistant to disease and tolerant to cold.

Rai and Yadav (2005) reported that Hebbal avare-3 is a derivative of the cross Hebbal avare-1 X US-67-13 and released from Karnataka in 1978. Plants are

65.75cm tall, erect, determinate and photo insensitive and matures in 70-110 days after sowing. Flowers are white, round and small.

The study conducted by Alkari *et al.* (2006) revealed that the dwarf type of lablab bean could be cultivated round the year, the selected traits for comparison were growth habit, earliness, yield, per day productivity and nutritional traits. Such type of improved cultivars with good pod traits has a good acceptability by the farmer and consumer.

An ultra short duration lablab bean culture, COLT 22/1 developed from the cross CO 9 x CO 4, is a photo-insensitive variety and can be grown throughout the year (Veerabadhiran *et al.*, 2006). This culture came to flowering in 40 to 42 days and the harvest of the green vegetable pods could be commenced from 48 days. Two or three pickings could be taken at ten days interval. The plant grows up to a height of 55 to 60 cm. The pod length ranged from 9 to12 cm with a width of 2 cm. Pod color is green.

2.2 Genetic variability

The extent of variability is of paramount importance in the improvement of any crop. Knowledge of available variability within the species enables the breeder to determine the method of crop improvement. Selection of superior types will be effective only when major part of the variability of the trait is genetic. Many workers studied the extent of variability in lablab bean by working out the genotypic and phenotypic coefficient of variation.

Joshi (1971) reported a wide range of phenotypic variability in yield and yield components of lablab bean. Pandey and Dubey (1972) revealed significant differences among the number of seeds pod^{-1}, 100 seed weight, protein content and yield. A high genotypic coefficient of variation (gcv) in characters like yield $plant^{-1}$, pod number and plant height was reported in lablab bean (Arunachalam, 1979).

Singh *et al.* (1979) reported a high genotypic coefficient of variation for all the characters except number of seeds pod^{-1} indicating the predominance of additive gene effects in lablab bean. Baswana *et al.* (1980) reported high gcv for pod weight, width and thickness, yield plant^{-1}, number of flowers inflorescence^{-1} and number of pods cluster^{-1} in *lablab purpureus*. Characters like number of days to flowering, pod size, number of pods plant^{-1} and number of flower cluster^{-1} showed a high and significant variation in lablab bean (Pandita *et al.*, 1980).

Singh and Gupta (1980) studied diallel of five varieties of *Lablab purpureus* in which four crosses showed heterosis over the better parent for leaf size. General combining ability variance was seven times higher than specific combining ability variance. The variety KT2 was a good general combiner and had the highest number of dominant genes. Additive gene effects were more important than nonadditive gene effects.

Jalajakumari (1981) studied genetic variability in seventeen cowpea varieties, and reported highly significant variation for all the characters. In lablab bean, Rao (1981) conducted the genetic analysis of quantitative characters and showed large genotypic coefficient of variation in the characters like pod yield plant^{-1}, inflorescence plant^{-1}and also plant height.

Variability studies in eleven cowpea varieties by Jana *et al.* (1982) revealed high genotypic coefficient of variation for vegetable yield and pods plant^{-1}. The number of primary branches plant^{-1} was positively correlated with vegetable pod yield. Evaluation of 81 genotypes at Hebbal, Bangalore by Nayar (1982) showed that high gcv was exhibhited for pods plant^{-1} and seed yield plant^{-1} in lablab bean. The characters like total number of pods plant^{-1}, pod yield plant^{-1}, seeds pod^{-1}, pods plant^{-1} and plant height showed high genotypic coefficient of variation in lablab bean (Reddy, 1982). The genetic coefficient of variation was the lowest (15.10 %)

for days to first picking and highest for pod width (36.5 %) and green pod yield plant^{-1} (30.67) (Singh *et al.*, 1982).

Vaid and Singh (1983) reported that branch number and yield plant^{-1} gave high values for phenotypic and genotypic coefficient of variation.

Das *et al.* (1987) observed the high genotypic coefficient of variation for all characters like pod yield plant^{-1}, number of pods plant^{-1} and breadth of pod in sixteen genotypes of lablab bean.

Information on genetic variance and heritability was derived by Ushakumari and Chandrasekharan (1992) from data on 11 quantitative and 6 qualitative traits in the parents and hybrids of a 6 X 6 diallel cross of *L. purpureus*. Predominantly dominant gene action was found for plant height, total leaf area, stem weight and green fodder yield.

Vasanthi and Das (1995) derived information on heterosis from data on 4 forage yield components in 36 F_1 hybrids from crosses between 9 lines and 4 testers evaluated at Killikulam during kharif 1993. Positive heterosis over the better parent for dry matter yield was highest (57.3%) in the cross MS 9448 X CO 1, while heterosis for crude protein content of the dry matter was highest (15.05%) in PLS 966 X CO 1.

During 1992-94, Desai *et al.* (1996) evaluated six varieties of lablab bean *Lablab purpureus* for 9 agronomic characters at Navsari. It was observed that branches/plant, clusters/plant, 100-seed weight, pods/plant and seeds/pod were the main yield contributing characters.

Uddin and Newaz (1997) studied the genetic variability and correlation in fifteen lablab bean genotypes including two exotic types. Results showed high gcv in green pod yield and number of green pods plant^{-1}. A moderately high gcv was

observed in individual pod weight, number of flowers cluster^{-1}, number of inflorescence plant^{-1} and rate of pod abortion.

Vashi *et al.* (1999a) reported that magnitude of heterosis over better parent was high for seed yield per plant followed by number of pods per plant and number of branches per plant in *Lablab purpureus*. Crosses exhibiting high heterosis for seed yield also depicted high heterosis for one or more yield attributing traits over their better parents.

Vashi *et al.* (1999b) conducted an experiment during season of 1995-96 to study the G x E interaction and stability performance in lablab bean *Lablab purpureus*. The G x E interactions was significant for all the traits except 100-seed weight. Among parents, NVS-141 was stable for seed yield per plant. While the high yielding hybrids NVS-61 x NVS-102, 125-36 x NVS-121 and Red Paria x NVS-102 were identified as stable for seed yield per plant, specifically under good farming conditions.

Biju (2000) studied fourty four accessions of lablab bean and reported that genetic coefficient of variation was found high for the characters like weight of pod, number of pods plant^{-1}, thickness of pod, pod length and yield plot^{-1}

Chetia *et al.* (2000) reported that mature seeds of five improved cultivars of lablab bean *Lablab purpureus* were analysed for nutritional and antinutritional factors. The cultivars showed considerable variation in their composition. On dry matter basis, the percentage of crude protein varied from 22.06 to 28.34, crude fat 1.62 to 2.22, crude fibre 6.02 to 10.63.

Vashi *et al.* (2001) studied the combining ability analysis of 6 hybrids based on 4 females and 15 males over 3 locations for 9 characters in lablab bean *Lablab purpureus* and revealed the importance of both additive and non-additive genetic

components. High yielding hybrids Red paria x AKW-9305, 125-36 x NVS-121, and NVS-61 x NVS-102 showed significant effects for seed yield per plant.

Bhuvaneshwari and Muthiah (2003) used four varieties of *Lablab purpureus var. typicus* (CO 9, CO 12, CO 13 and COLT 22) in selective mating for the study of inheritance patterns of pod colour, stem colour and pod shape. The pod colour varied from light green to dark green and dark purple; while stem color was green and purple and pod shape was flat and tubular.

A cross DL 3196 x CO 11 showed high significant specific combining ability effects for yield, pod yield and number of seeds plant^{-1} in lablab bean. (Kannan *et al,* 2003).

Kumari *et al.* (2003) evaluated fifty genotypes of cowpea to estimate the variability, heritability correlations and path coefficients for ten morphological traits, during Kharif, 2001. Maximum range of variation was noted for plant height.

Murthy and Kumar (2004) observed that the field bean variety Hebbal avare-3 flowered in 58 days and reached its physiological maturity in 90 days after sowing. The seed development period was 27 days. The 100 seed weight was 9.2 g at seed moisture content of 9 per cent and germination percentage of the developing seeds progressively increased from 20-34 days from anthesis.

Singh *et al.* (2004) conducted a study from 1995 to 1998 to screen different strains of *Lablab purpureus* in rainfed conditions of Bullowal Saunkari, in Punjab. Fifteen genotypes of lablab bean were evaluated. The variation for days to flower initiation, pod length, pod width and green pod yield per plant ranged from 67.4 to 108.9 days, 5.0 to 11.6 cm, 1.7 to 2.7 cm and 0.376 to 2.596 kg, respectively. The estimates of genetic variance component and broad sense heritability (hb^2) was 93.06 (0.65), 3.41 (0.86), 0.04 (0.50), 0.21 (0.87) for days to

flower initiation, pod length, pod width and green pod yield per plant, respectively.

Chikkadevaiah *et al.* (2005) reported trigenic ratios for the following characters: habit of the plant, inflorescence type, pod form and pod colour. The first two characters showed the presence of 3 common genes and the latter ones are independent.

Prashanthi (2005) studied the inheritance of photoperiod sensitivity in lablab bean in two crosses in which simple dominance of photosensitivity over phtoinsensitivity was observed.

In an exploration by Mohan and Aghora (2006) in the central Tamil Nadu 97 pole type of lablab bean was collected out of which Maximum pod length was recorded in IIHR 0486 (18.3 cm) and pod width in IIHR 049(4.0 cm). Average pod weight was highest in IIHR 0413 (18g).

Singh and Singh (2006) observed the maximum variability for seed yield plant^{-1}, followed by pods plant^{-1}, plant height, branches plant^{-1} and 100-seed weight in field pea.

Lablab bean plants are robust, leaves are pinnately trifoliate, base broadly rounded or very obtuse, apex acuminate to acute, glabrous except on veins. Flowers are violet or white, in long stalked, many flowered, axillary racemes. Pods are subsessile, tuberculate on sutures, 3-6 seeded. Seeds are variable in colour as white, ochreous with black dots or black with white dots, uniformly brown or uniformly black (Rai et al., 2007).

2.3 Heritability and genetic advance

In a study conducted by Singh *et al.* (1979) using 48 strains of lablab bean showed high values for heritability in all characters. Among these, days to flower and yield plant^{-1} showed very high heritability while number of seeds pod^{-1} showed the lowest. Basawana *et al.* (1980) reported high heritability and genetic advance for yield plant^{-1}, pod weight, pod width and number of flowers inflorescence^{-1} in lablab bean.

Rathnaiah (1982) reported high heritability and genetic advance for the characters namely plant spread, green pod yield, yield unit area^{-1}, number of pods plant^{-1} and number of inflorescence plant^{-1} in lablab bean.

Reddy (1982) conducted a study on heritability and showed high heritability and genetic advance for seeds plant^{-1}, total pods plant^{-1}, seed pod-^{1}, plant height, effective spike length, internodal length and flowers spike^{-1} in lablab bean.

High heritability and high genetic gain was reported by Singh *et al.* (1982) for the characters of pod width and number of pods cluster^{-1} in lablab bean.

Philip (1984) observed high heritability for crude protein and crude fibre content in winged bean, but genetic advance was low.

Singh *et al.* (1985) evaluated eighteen genotypes of lablab bean and reported that pod width and number of pods cluster^{-1} combined relatively high values for expected genetic advance and heritability. Studies conducted in 16 genotypes of lablab bean showed high heritability with greater genetic advance for pod yield plant^{-1}, number of pods plant^{-1} and breadth of pod (Singh *et al.*, 1986). Das (1987) indicated that 100 seed weight and green pod yield plant^{-1} had high heritability of 91.4 per cent and 85.6 per cent respectively.

Newaz (1990) conducted a study on thirteen genotypes of lablab bean in Bangladesh and showed high heritability as well as high genetic advance for pod yield, number of pods plant^{-1}, number of inflorescence cluster^{-1} and pod weight.

Gupta and Samantha (1991) derived information on genetic variability and heritability from data on 11 yield components in 7 *Lablab purpureus* and 1 *Lablab biflorus* [*Macrotyloma uniflorum*] genotypes and their F_1 hybrids.

In lablab bean Borah and Shadeque (1992) estimated high heritability and genetic advance in characters like pod weight, pod breadth and vitamin C content. Singh (1993) reported that high heritability estimates associated with high genetic advance were found for green pod yield plant^{-1} and 100 seed weight in french bean.

Genetic advance and heritability were estimated by Desai *et al.* (1996) in lablab bean which revealed that there was ample scope for improvement in number of branches, seeds pod^{-1}, days to flowering, days to maturity, 100 seed weight and yield. A study conducted by Uddin and Newaz (1997) in lablab bean showed high heritability and genetic advance in characters like pod yield, number of pods plant^{-1} and pod weight.

Highest heritability was observed for weight of pod followed by pod length, shelling percentage and girth of pod. (Biju, 2000).

Basu *et al.* (2002) used seven cultivars of *Lablab purpureus* for study of genetic analysis and combining ability effects, where JDL-73 x Hebbal, HD-18 x JDL-73, and HD-18 x JDL-53 were identified as potential specific combiners. The highest magnitude of heritability in the narrow sense was recorded for single seed weight. Minimum heritability in the narrow sense was recorded for seed length and seed yield per plant.

Rai *et al.* (2004) revealed that the high genotypic coefficient of variation along with high heritability and genetic advance were recorded for pod yield plant^{-1}, number of pods plant^{-1} and pod weight in French bean.

High heritability and genetic advance over three seasons observed for green pod yield plant^{-1}, seed yield plant^{-1}, hundred seed weight and pod length indicated that the variation in these characters was most likely due to additive genes, hence simple direct selection may be effective to improve these characters (Ampily, 2005).

Bhuvaneshwari and Muthiah (2005) reported that twelve hybrids generated from a 4 X 4 Diallel analysis involving CO-9, CO-12, CO-13 and COLT-22 as parents expressed wide range of heterosis.

High expected genetic advance coupled with high heritability estimates were predicted for seed yield plant^{-1}, pods plant^{-1} and plant height indicating least influence by the environmental variation in field pea. (Singh and Singh, 2006)

Mozumdar *et al.* (2007) conducted an experiment in two consecutive cropping seasons to study the influence of support systems and spacing on lablab bean production. The maximum net return was obtained from CBRO 115 with branched bamboo stick support at 1 x 1 m spacing with highest BCR of 4.76.

2.4 Correlation

Yield in any crop is a complex character determined by many component characters. Selection of specific characters result in correlated response for some other characters. Interrelationships between yield and its contributing characters have been reported by many workers in lablab bean and related crops.

Basawana *et al.* (1980) studied 39 genotypes of lablab bean and revealed a positive correlation between yield and weight of pod, of which latter was again correlated positively with length of pod, width of pod and seeds pod^{-1}. In Indian bean, Pandita *et al.* (1980) observed that inflorescence length and pod length were positively and highly correlated with yield where as days to flowering was negatively correlated with yield.

A study by Rao (1981) revealed that inflorescence and pods $plant^{-1}$ showed high positive and significant correlation with pod and seed yield $plant^{-1}$ which in turn showed high positive and significant correlations among themselves.

Sathyanarayana and Gangadharappa (1982) reported that the green pod yield in lablab bean was significantly and positively correlated with weight of pods, breadth of pod and length of pod and percent dry weight of green pods also showed significant positive genotypic correlation with yield, but were found to be influenced by the environment. Singh *et al.* (1982) revealed that the green pod yield $plant^{-1}$ had significant and positive correlation with pod width and 100 seed weight in lablab bean.

A study by Jindal and Gupta (1984) in cowpea revealed that plant height, inflorescence $plant^{-1}$, pod length and seeds pod^{-1} were significantly and positively associated with seed yield.

Tyagi and Koranne (1988) observed that branches plant^{-1} and seeds pod^{-1} were positively and significantly correlated with yield. Similar results have been obtained by Patil *et al.* (1989). Highly significant positive correlation of seed yield with inflorescence plant-1, pods plant^{-1} and seeds pod^{-1} was observed by Apte *et al.* (1991)

Gopalan and Balasubramanian (1993) observed positive and significant genotypic correlation of green fodder yield with plant height, number of leaves and stem girth. Kandaswamy *et al.* (1993) reported positive association of pods plant^{-1} and cluster plant^{-1} with yield in cowpea.

Nandi *et al.* (1997) observed that pod weight and pod girth were positively and significantly correlated with green pod yield plant^{-1}. The number of pods plant^{-1} was closely associated with green pod yield plant^{-1} in lablab bean.

Uddin and Newaz (1997) conducted correlation study of lablab bean in Bangladesh, which showed a positive association of number of flowers in the inflorescence with rate of flower abortion and number of green pods. Green pod yield had strong and significant positive association with pod number, inflorescence plant^{-1} and pod weight.

Biju (2000) revealed that yield was significantly and positively correlated with fruit setting percentage and number of seeds plant^{-1} both genotypically and phenotypically.

Rai *et al.* (2003) reported that number of pods plant^{-1} and weight of 100 pods had positive and strong correlation with yield where as number of pods plant^{-1} recorded maximum direct effect towards yield in Indian bean. Correlation and path analysis conducted by Narayanan kutty *et al.* (2003) on 37 divergent genotypes of vegetable cowpea revealed that number of pods plant^{-1}, number of pickings, average weight of pods and pod length were positively and significantly correlated with yield plant^{-1} both at phenotypic and genotypic levels.

Bagade *et al.* (2004) reported that the seed yield plant^{-1} was positively and significantly associated with pods plant^{-1} and negatively correlated with plant height. Pods plant^{-1} had the highest direct effect followed by 100 seed weight on seed yield in a diallel cross of lablab bean.

Aher *et al.* (2006) reported that most characters of genotype TAU-1 of black gram showed either significant or non-significant and positive correlation with grain yield.

2.5 Path coefficient analysis

The path coefficient provides an effective means of finding out direct and indirect causes of association and allows a detailed examination of specific forces acting to produce a given correlation and measures the relative importance of each factor.

Pandita *et al.* (1980) reported that in dolichos bean days to flowering, hundred seed weight and pod width have direct effect on yield.

Reddy (1982) revealed that pods spike^{-1}, percentage of pods spike^{-1}, percentage of pod set, productive pods plant^{-1} and seeds plant^{-1} had large positive direct effects on bean yield in lablab bean.

Path coefficient analysis in lablab bean revealed that weight of pod exerted high direct effect on green pod yield, followed by length of inflorescence and days to first flowering. Pods plant^{-1}, bunches plant^{-1} and percent dry weight of green pods influenced yield indirectly (Sathyanarayana and Gangadharappa, 1982).

Rathnaiah (1985) conducted the path coefficient analysis in lablab bean and reported that plant spread and number of pods plant^{-1} had the highest positive and direct effects on green pod yield plant^{-1}.

Path coefficient analyses by Dahiya *et al.* (1992) using 36 genotypes of lablab bean (*Lablab purpureus*) revealed that increased yield in lablab bean may be brought about by selecting for number of pods plant^{-1}, plant height and pod weight.

Path coefficient analysis by Oseni *et al.* (1992) showed that days to flowering had the highest direct effect on grain yield followed by 100 seed weight, days to pod filling and pod length in cowpea.

Kandaswamy *et al.* (1993) reported that the clusters plant^{-1} had the highest positive direct effect of 0.886 followed by seeds pod^{-1} and 100 seed weight (0.27 and 0.226 respectively). Though pod length had a weak direct effect, its indirect effect through seeds pod^{-1} was higher.

Desai *et al.* (1996) conducted the path coefficient analysis in *Dolichos lablab var. lignosus* and revealed that number of primary branches and seeds pod^{-1} had the highest direct positive effect on yield.

Nandi *et al.* (1997) derived information on path analysis from 20 local lines of *Lablab purpureus* grown at Keonjhar, Orissa, in 1994. Pod weight and pod girth were positively and significantly correlated with green pod yield plant^{-1}. The number of pods plant^{-1} was closely associated with green pod yield plant^{-1}.

Path coefficient at genotypic level revealed that seed diameter, pod weight, seed weight and pods plant^{-1}, showed maximum positive direct effect on pod yield plant^{-1} indicated that these are the main contributors to yield. (Biju *et al.*, 2001) in lablab bean.

In a field experiment conducted by Bagade *et al.* (2002) in Gujarat, during the rabi season of 2001, combining ability analysis of 45 F_1s of an lablab bean *(Lablab purpureus)* in a diallel cross and their 10 parents showed that additive gene effects influence most of the traits studied in the crop. The predominance of non-additive

gene effects was observed in the inheritance of number of branches plant^{-1} and seeds pod^{-1}.

Path analysis studies by Kumari *et al.* (2003) revealed that clusters plant^{-1}, 100-seed weight and days to maturity had the maximum and desirable direct as well as indirect effects on seed yield plant^{-1}. The results of present study suggested that selection based on the above three characters might bring simultaneous improvement in yield.

Path coefficient analysis conducted by Tikka *et al.* (2003) revealed that pods plant^{-1}, pod length, branches plant^{-1}, plant height and harvest index were the main yield contributing traits in lablab bean. Positive direct effects and positive significant association were observed for these traits.

In a study conducted by Nath and Korla (2004) involving twenty eight-dwarf french bean genotypes. Eight quantitative characters were analysed for path coefficients in relation to pod yield and found that numbers of pods plant^{-1}, pod length and harvest index have significant positive association with pod yield.

Path analyses of F_2 populations in Black gram were studied by Veeramani *et al.* (2005) for eight characters. It revealed that direct effect on seed yield was exerted by the characters namely number of clusters plant^{-1}, Number of pods plant^{-1} and pod length.

2.6 Genetic divergence

The knowledge of nature and degree of divergence in existing germplasm are basic pre-requisites in breeding programme of any crop including lablab bean for effective selection of superior genotypes. A study by Baswan *et al.* (1980) indicated that the number of pods plant^{-1} contributed the most to divergence, followed by pod

weight and yield in his clustering analysis on the basis of Mahalanobis-D^2 statistics in lablab bean.

Studies conducted by Nayar (1982) on genetic divergence and breeding behaviour of lablab bean revealed considerable variability for all traits. Days to flowering, days to maturity and seed protein content contributed most to divergence.

Marangappanavar (1986) concluded that, inter cluster spatial patterns were not consistent with varietal geographical distribution, following his clustering studies in cowpea.

Seventy five genotypes of *Dolichos biflorus* were grouped into five clusters by Mishra *et al.* (1987) based on yield and 11 yield related characters. Studies on divergence by Sharma and Luthra (1987) in *Dolichos biflorus* using 56 genotypes concluded that, the composition of clusters formed using D^2 statistics differed between groups, due to environmental variations.

According to Sickhar *et al.* (1988) the degree of expression of economic characters was also as important as genetic distance of the parents involved in the crosses. Thiagarajan *et al.* (1988) reported that days to 50 per cent flowering, 100 seed weight and plant height contributed most to genetic divergence in cowpea.

Studies by Kumari and Chandrasekaran (1991) using 30 genotypes of *lablab purpureus* revealed that all the genotypes were genetically divergent for all characterstics studied. Leaf number made the greatest contribution to the genetic diversity, followed by dry matter production and plant height.

Singh (1991) used Mahalanobis-D^2 statistical analysis and found that the days to flowering and number of pods per cluster were contributing most to divergence in lablab bean. Birari and Ghanekar (1992) studied genetic diversity derived from the data on 15 quantitative characters of lablab bean (*lablab purpureus*). The genotypes

were grouped in to seven clusters on the basis of D^2 and canonical analysis and the selection was made based on high seed yield plant^{-1} (94.8g plant^{-1}).

A study conducted by Hazra *et al.* (1993) on genetic divergence among the cowpea genotypes belonging to three culti groups, *unguiculata, biflora and sesquipedalis* under two environments. Using D^2 statistics, the genotypes were grouped in to four clusters in both the environments. No close correspondence was observed between geographic distribution and genetic divergence. Genetic divergence in cowpea using Mahalanobis-D^2 technique was studied by Sudhakumari and Gopimony (1994) and they reported that the intercluster distance was more than the intracluster distances suggesting homogeneity within the clusters and heterogeneity between the clusters. Maximum divergence was observed between clusters V and VII, which indicated that parents chosen from these are likely to produce better recombinants with better adaptability in hybridization works.

Thirty one cowpea genotypes were grouped in to six clusters (Sobha, 1994). The clustering pattern did not show any strict parallelism with the geographic source, in this study maximum distance (D = 48.3) existed between cluster I and IV.

Nandi *et al.* (1998) at Keonjhar carried out analysis of genetic divergence in 28 lablab bean genotypes in 1994, using the Mahalanobis D^2 statistics. Genotypes were grouped into 10 clusters. Maximum intracluster D^2 values were recorded in Cluster V. The intercluster D^2 values indicated maximum statistical distance between clusters VI and VIII, followed by clusters VI and IX, V and VI and VI and VII.

Biju (2000) studied genetic divergence in fourty four genotypes of lablab bean using D^2 technique and reported that maximum statistical distance was found between cluster V and VIII followed by cluster V and VI. The distance between the cluster III and IX displayed the lowest degree of divergence.

Nandi *et al.* (2000) conducted a study during 1994-95, using Mahalanobis D^2 statistic to analyse the genetic diversity in 28 genotypes of lablab bean (*Lablab purpureus*) based on data for 8 yield components. The genotypes were grouped into 5 clusters, Cluster V recorded the highest mean pod length, pod weight, seeds pod^{-1} and green pod yield $plant^{-1}$.

Chaubey *et al.* (2003) observed from the 30 genotypes which he grouped in to six clusters on the basis of D^2 value that cluster III was the best as the genotypes belonging to this showed high seed yield, 100 seed weight, plant height and harvest index. Genotypes in cluster IV were earliest in flowering and maturity. Rai *et al.* (2003) studied genetic divergence and path analysis in 45 diverse types of lablab bean using D^2 technique and reported that the maximum genetic divergence was observed between cluster I and cluster V followed by cluster IV, cluster II and III which displayed lowest degree of divergence.

Eighteen diverse types of lablab bean (*Lablab purpureus L.*) were evaluated for genetic divergence, yield and its contributing characters by Golani *et al.* (2006). They grouped the genotypes in to eight clusters, the maximum genetic distance was observed between cluster III and cluster V. the maximum intracluster distance was exhibhited by cluster IV, the mean values for most of the traits was highest in cluster VIII.

2.7 Selection Index

To make effective selection for higher yield, it is necessary to determine the selection index.

Selection indices in lablab bean was worked out by Rathnaiah (1982) using characters like number of pods $plant^{-1}$, plant spread, green pod yield $plant^{-1}$, number of inflorescences $plant^{-1}$ and length of inflorescence and pod.

A study by Singh *et al.* (1982) indicated that green pod yield plant^{-1} showed a significant effect on pod weight and 100 seed weight in lablab bean and these characters were ideal for effective selection.

The characters such as days to final harvest, number of pods plant^{-1}, and girth of pod were used for selection index analysis in winged bean (Philip 1984).

In lablab bean Das *et al.* (1987) reported that characters like pod yield plant^{-1}, number of pods plant^{-1} and breadth of pod were effective for selection.

The increased yield in lablab bean was brought about by selecting for number of pods plant^{-1}, plant height and pod weight (Dahiya *et al.*, 1992).

In 12 local cultivars of lablab bean, Borah and Shadeque (1992) reported that selection index based on inflorescence length, pod weight, pod breadth, pod yieldplant^{-1} and pod length resulted in higher yield.

In lablab bean, characters like number of pods plant^{-1}, inflorescence plant^{-1} and pod weight were effective for improvement of yield (Uddin and Newaz, 1997).

Mathew (1999) reported that, characters to be considered for selection index were selected based on their phenotypic correlations, direct and indirect effects on yield, variability and heritability.

Based on index selected for lablab bean, the accession DL-6 was found to be most superior followed by accessions DL-29, DL-40 and DL-66. Accession DL-6 was the highest yielding with an average yield of 7.1 kg plot^{-1}. (Biju, 2000).

The selection involving all the yield components was observed to have the maximum efficiency compared to direct selection based on yield (Cherian, 2000).

Studies by Kumari *et al.* (2003) suggested that selection based on clusters plant^{-1}, 100-seed weight and days to maturity might bring simultaneous improvement in yield.

The characters pods plant^{-1}, pod length, branches plant^{-1}, plant height and harvest index should be considered for selection in order to bring improvement in grain yield (Tikka *et al.*, 2003).

Rai *et al.* (2004) reported that maximum direct effect of seed diameter, pod weight and number of pods plant^{-1} towards yield indicated that these characters were very important while making selection for high yielding genotypes in french bean.

2.8 Quality

In a comparison between 4 non-season-bound *Lablab purpureus* cultivars developed at the University of Agricultural Sciences, Bangalore and 2 local season bound cultivars, average seed protein content of the non season bound cultivars was 27.2%, compared with 26.5 and 23.8% for the 2 local cultivars, respectively (Srihara, 1976).

Study conducted by Nayar (1982) on lablab bean revealed considerable variability for all traits. Days to flowering, days to maturity and seed protein content contributed most to divergence.

Aletor and Aladetimi (1989) evaluated some cowpea varities with respect to their proximate chemical composition, mineral content and some endogenous toxic constituents. The cowpea varieties contained on the average 22.5 g crude protein (CP), 2.60 g crude fibre (CF), 5.89 g either extract (EE) and 3.36 g ash/100 g DM.

Vasanthi and Das (1995) derived information on heterosis from data on 4 forage yield components in 36 F_1 hybrids from crosses between 9 lines and 4 testers

evaluated at Killikulam during kharif 1993. Positive heterosis over the better parent for dry matter yield was highest (57.3%) in the cross MS 9448 x CO 1, while heterosis for crude protein content of the dry matter was highest (15.05%) in PLS 966 x CO 1.

Murphy and Colucci (1999) recorded the levels of crude protein in total plant, leaf, stem and seed fractions of lablab bean. The mean crude protein content of lablab herbage was 17% with a range of 10% to 22% on a dry matter basis. Leaf crude protein varied from 14.3% to 38.5%, while the stem crude protein content ranged from 7.0% to 20.1%. Lablab bean follows a familiar growth pattern as protein content drops with maturity.

Mature seeds of five improved cultivars of lablab bean (*Lablab purpureus* L.) were analysed for nutritional and antinutritional factors (Chetia *et al.*, 2000). The cultivars showed considerable variation in their composition. On a dry matter basis, the percentage of crude protein varied from 22.06 to 28.34, crude fat 1.62 to 2.22, crude fibre 6.02 to 10.63 and total carbohydrate 57.51 to 64.70. The amounts (mg/100 g) of calcium, phosphorus, iron, sodium and potassium ranged from 28 to 48, 330 to 415, 5.60 to 6.94, 0.482 to 0.684 and 10 to 15, respectively.

Materials and Methods

3. MATERIALS AND METHODS

The investigations were carried out at the vegetable research farm of the Department of Olericulture, College of Horticulture, Vellanikkara during 2006-2007. The experimental field is located at an altitude of 22.5m above MSL, between 10^0 32' N latitude and 76^0 16' E longitude. The experimental site has a sandy loam soil, which is acidic in reaction (pH 5.3). The area lies in tropical monsoon climatic region, with more than 80 per cent of the rainfall getting distributed through southwest and northeast monsoon showers. Data on temperature, rainfall, relative humidity, number of rainy days and sunshine hours during the entire cropping period were collected from meteorological observatory of College of Horticulture, Vellanikkara (Appendix I).

Season of experimentation

The crop was raised during two cropping seasons viz., Rabi (September – December 2006) and summer (January – May 2007).

Studies were undertaken under the following two major heads

3.1 Genetic cataloguing of lablab bean.

3.2 Evaluation of genotypes of lablab bean.

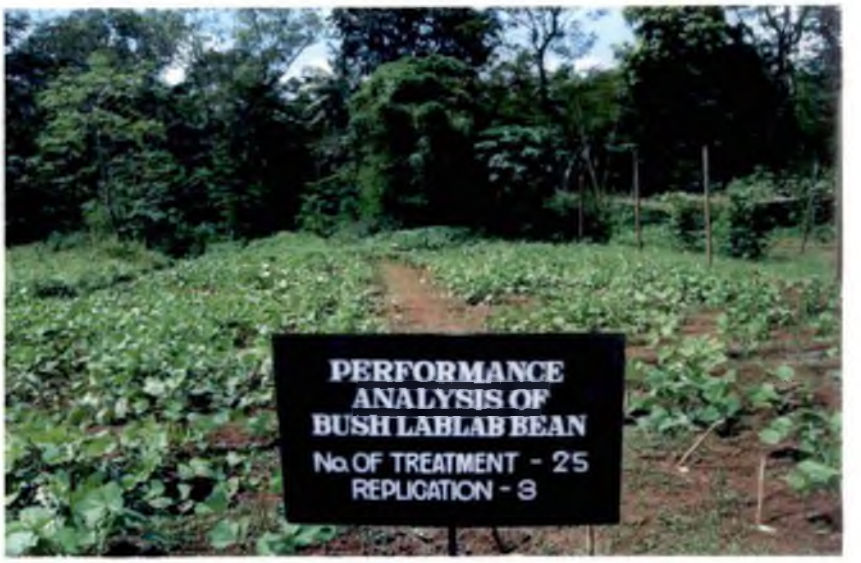
3.1 Genetic cataloguing of lablab bean

Twenty five accessions collected from different parts of the country (Table 1) were genetically catalogued based on the descriptor developed for the lablab bean (Table 2).

Table 1. Lablab bean accessions used in the study

SL.No.	Accession number	Source
1	LP-1	Karaikal
2	LP-2	Karaikal
3	LP-3	Coimbatore
4	LP-4	Coimbatore
5	LP-5	Coimbatore
6	LP-6	Coimbatore
7	LP-7	Bengaluru
8	LP-8	Bengaluru
9	LP-9	Dharawad
10	LP-10	Belagavi
11	LP-11	Belagavi
12	LP-12	Belagavi
13	LP-13	Belagavi
14	LP-14	Belagavi
15	LP-15	Belagavi
16	LP-16	Coimbatore
17	LP-19	Harapanahalli
18	LP-20	Kadur
19	LP-21	Bellary
20	LP-22	Tipture
21	LP-23	Davangere
22	LP-24	Birur
23	LP-25	Davangere
24	LP-26	Kuremaganahalli
25	LP-27	Nadia

Plate - 1. View of the experimental plot at different stages



30 Days

45 Days

60 Days

3.2 Evaluation of variability in lablab bean

3.2.1 Experimental materials

The experimental materials consisted of 25 accessions collected from different parts of India.

3.2.2 Experimental methods

The 25 lablab bean genotypes were raised in a randomized block design with three replications during September-December 2006 and January-May 2007 (Plate 1). The plot size was 3.0m x 1.5m with one row of plants/genotype/replication. There were 10 plants replication^{-1} at 0.75m x 0.6m spacing. The crop received timely management and care as per the Package of Practices Recommendations of Kerala Agricultural University (KAU 2002).

Weeding was done at 15 days interval. During the cropping period, plant protection measures were undertaken for the control of Sclerotia rot (cottony rot), leaf eating caterpillars, pod borers and aphids. Irrigation was given at two days interval during the dry periods.

3.2.3 Observations

For taking observations, three plants were selected from each genotype per replication. Following parameters were recorded and average was worked out for further analysis.

a) Plant height (cm)

The plant height from the ground level to the tip of the plant was measured and average recorded in centimeters.

b) Plant spread (cm)

Canopy spread of the plant was measured at the full maturity of the plant in centimeters using metre scale.

Table 2. Genetic cataloguing of lablab bean (*Lablab purpureus (L.) Sweet*)

1. Vegetative and floral characterstics	
1.1 Growth habit	- Bush/Semi viny/Viny
2 Leaf vein colour	- Light green/ Green/Purple
3 Stem colour	- Light green/ Green/Purple
4 Flower stalk	- Present/Absent
5 Flower colour	- White/Purple
6 Utility type	- Vegetable type/ Dual/ Pulse type
7 Flowering behaviour	- Rabi/Summer
2. Pod characteristics	
2.1 Pod shape	- Straight/ Curved/Slightly curved
2 Pod suture colour	- White /Purple
3 Pod curvature	- Straight/ Curved/Slightly curved
4 Pod colour	- Green/ Light green/Creamish green/ Purple
5 Pod surface	- Smooth/ Wrinkled
3. Seed characteristics	
3.1 Seed size	- Big/ Medium/Small
2 Seed shape	- Round/Flat/Oval/Oblong
3 Seed colour	- Light brown/Dark brown/Creamish white/Black

c) Primary branches per plant

The number of branches originating from the main stem was counted.

d) Leaf length (cm)

Length of 5 randomly selected and fully expanded leaves were recorded and the mean was computed.

e) Leaf width (cm)

The same leaves used for measurement of leaf length were used for measuring width and the mean was computed.

f) Pedicel length (cm)

The same leaves used for measurement of leaf length were used for measuring pedicel length and the mean was computed.

g) Days to first flowering

The number of days was counted from date of sowing to the opening of first flower.

h) Days to 50 per cent flowering

The number of days from sowing to the appearance of flowers in 50 per cent of the plants was recorded.

i) Days to first harvest

The number of days from sowing to the date of first harvest of the fruits at vegetable maturity was noted.

j) Days to final harvest

The number of days from sowing to the date of final harvest of the fruits at vegetable maturity was noted.

k) Days to vegetable maturity

The days taken from flower opening to the vegetable maturity of the pod in each plant was recorded.

l) Pod setting (%)

Ten flowers were tagged at random on the plant and number of pods set was recorded. The percentage of pod set was then worked out.

m) Pod length (cm)

Length of 18 randomly selected pods at vegetable maturity was measured and average recorded in centimeters.

n) Pod girth (cm)

The same pods used for length measurements were used for recording pod girth. The girth of eighteen pods was measured and the average recorded in centimeters.

o) Pod weight (g)

The weight of the nine pods was taken in an electronic balance and the average was worked out.

p) Pod thickness (cm)

This was measured in centimeters using Vernier Calipers at the broadest region of three randomly selected pods and the mean worked out.

q) Number of pods per plant

The total number of pods produced per plant at the time of harvest was observed.

r) Pod yield per plant (kg)

Pods were harvested separately from each plant periodically and weighed using a top loading balance.

s) Pod yield per plot (kg)

Pods were harvested separately from each plot periodically and weighed using a top loading balance.

t) Shelling percent

After harvest, the weight of the shell is taken separately and shelling percentage was calculated by the formula.

$$\text{Shelling percent} = \frac{\text{Weight of seed}}{\text{Weight of dry pod}} \times 100$$

u) Number of seeds per pod

The number of seeds in 9 pods was counted and recorded as the average.

v) Hundred seed weight (g)

One hundred fully matured and dried seeds from each genotype were weighed using an electronic precision balance and the weight recorded in gram.

w) Crude fibre

Crude fibre content was estimated by acid alkali digestion method as suggested by Sadasivam and Manickam, 1992.

x) Crude protein

The protein content was estimated using the method of AOAC (1980).

y) Pests and diseases

The incidence of pests and diseases were observed and recorded.

3.2.4 Statistical analysis

Data on different characters were subjected to statistical analysis, using Spar-1 package. The analysis of variance technique suggested by Fisher (1954) was employed for the estimation of various genetic parameters like analysis of variance, genotypic and phenotypic coefficient of variation, genotypic and phenotypic correlation coefficients and path coefficient analysis for estimation of direct and indirect effects.

3.2.4.1 Phenotypic, genotypic and environmental variance

The variance components were estimated using the formula suggested by Burton (1952).

Phenotypic variance (Vp) = Vg+Ve

Where,

Vg- genotypic variance

Ve- environmental variance

Genotypic variance (Vg) = $(V_T-V_E)/N$

Where,

V_T- mean sum of squares due to treatments

V_E -mean sum of squares due to error

N- Number of replications

Environmental variance (Ve) = V_E

3.2.4.2 Phenotypic and genotypic coefficient of variation

The phenotypic and genotypic coefficient of variation was calculated by the formula suggested by Burton and Devane (1953).

Phenotypic coefficient of variation (pcv) = $(Vp^{1/2}/ X) \times 100$

Where,

Vp- Phenotypic variance

X- Mean of characters under study

Genotypic coefficient of variation (gcv) = $(Vg^{1/2}/ X) \times 100$

Where,

Vg-Genotypic variance

X- Mean of characters under study

3.2.4.3 Heritability

Heritability in the broad sense was estimated by the formula suggested by Burton and Devane (1953).

$H^2 = (Vg/Vp) \times 100$

Where,

Vg- genotypic variance

Vp-phenotypic variance

The range of heritability was categorized as suggested by Robinson *et al.* (1949) as

0-30 per cent	-	low
31-60 per cent	-	moderate
61 per cent and above	-	high

3.2.4.4 Expected genetic advance

The genetic advance expected for the genotypic variance was calculated using the formula by Lush (1949) and Johnson *et al.* (1955) with value of the constant K as 2.06 as given by Allard (1960).

Expected genetic advance $GA = (Vg/Vp^{1/2}) \times 2.06$

Where

Vg= Genotypic variance

Vp= Phenotypic variance

3.2.4.5 Genetic gain (genetic advance as percentage of mean)

Genetic advance (GA) calculated by the above method was used for estimation of genetic gain.

Genetic gain, $GG = (GA/X) \times 100$

Where,

GA=Genetic advance

X= Mean of characters under study

The genetic gain was classified according to Johonson *et al.* (1955) as follows

1-10 per cent	-	low
11-20 per cent	-	moderate
21 per cent and above	-	high

3.2.4.6 Phenotypic and genotypic correlation coefficients

The Phenotypic and genotypic correlation coefficients were worked out to study the extent of association between the characters. The Phenotypic and genotypic correlation coefficients among the various characters were worked out in all possible combinations according to the formula suggested by Johnson *et al.* (1955).

Phenotypic correlation coefficients between two characters 1 and 2 was calculated by the formula

$$(rp12) = COVp12/ (Vp1.Vp2)\ 1/2$$

Where,

Vp1 = Phenotypic variance of character 1

Vp2 = Phenotypic variance of character 2

Genotypic correlation coefficient between two characters 1 and 2 was calculated by the formula

$$(rg12)=COVg12/ (Vg1.Vg2)\ 1/2$$

Where,

Vg1= Genotypic variance of character 1

Vg2= Genotypic variance of character 2

3.2.4.7 Path coefficient analysis

In path coefficient analysis the correlation among cause and effect are partitioned in to direct and indirect effects of casual factors on effect factor. The principles and techniques suggested by Wright (1921) and Li (1955) for the analysis using the formula given by Dewey and Lu (1959).

3.2.4.8 Genetic divergence

The genetic divergence among 25 accessions were assessed based on different characters as given by Mahalanobis (1936). Clustering of genotypes using Mahalanobis D^2 value was carried out using the computer oriented iterative algorithm method as suggested by Suresh and Unnithan (1996).

3.2.4.9 Selection index

Smith (1936) model was used for formulating the selection index. This is desired to select plants, the merit (H) of which is linearly expressed as:

$$H = a_1G_1 + a_2G_2 + \ldots\ldots\ldots + a_nG_n$$

Where, G_1, G_2.....G_n represents the genotypic values of characters and a_1, a_2...a_n denote the weights to be assigned to each of the character.

Results

4. RESULTS

The results obtained from the present investigation are presented under the following heads

4.1. Genetic cataloguing in lablab bean.

4.2. Evaluation of variability in lablab bean.

4.1 Genetic cataloguing in lablab bean

Based on descriptor mentioned in Table 2, twenty five accessions of lablab bean were genetically catalogued for vegetative, flowering, pod and seed characters (Table 3).

The accessions included in the study varied from bush to semi viny type of growth habit (Plate 2, 3 and 4). Flower colour was found to be white and purple (Plate 5).

Pod colour varied between light green, green and purple. Pods were either curved or slightly curved in shape.

Pod surface was found to be smooth and wrinkled. Seed size varied from small and medium to big and seed shape varied from oval and flat oval to oblong. Seed colour was found to be black, dark brown, light brown and creamish white. Accessions were pulse or vegetable type according to their utility.

4.2 Evaluation of variability in lablab bean

4.2.1 Variability

The mean performance of 25 accessions is presented in tables 4, 5, 6, and 7. The results showed significant difference between the accessions for all characters

Table 3. Morphological characters of lablab bean.

Sl.No	Acc.No.	Growth habit	Stem color	Leaf vein color	Flower stalk	Flower color	Flowering behaviour	Pod color	Pod suture color	Pod shape	Pod curvature	Pod surface	Seed size	Seed shape	Seed color	Utility type
1	LP-1	Bush	Light green	Light green	Present	Purple	Rabi & summer	Green	White	Curved	Curved	Smooth	Big	Flat oval	Light brown	Pulse
2	LP-2	Semi viny	Light green	Light green	Present	Purple	Rabi	Green	White	Curved	Curved	Wrinkled	Small	Oblong	Light brown	Pulse
3	LP-3	Semi viny	Light green	Light green	Present	White	Rabi & summer	Creamish green	White	Curved	Curved	Smooth	Medium	Oblong	Dark brown	Vegetable
4	LP-4	Semi viny	Purple	Purple	Present	Purple	Rabi & summer	purple	Purple	Curved	Curved	Wrinkled	Small	Oblong	Black	Vegetable
5	LP-5	Bush	Light green	Light green	Present	White	Rabi & summer	Green	White	Slightly curved	Slightly curved	Wrinkled	Medium	Oblong	Dark brown	Vegetable
6	LP-6	Bush	Green	Green	Present	White	Rabi & summer	Green	White	Curved	Curved	Wrinkled	Medium	Oblong	Dark brown	Vegetable
7	LP-7	Bush	Light green	Light green	Present	White	Rabi & summer	Green	White	Curved	Curved	Smooth	Medium	Oblong	Creamish white	Pulse
8	LP-8	Bush	Light green	Light green	Present	White	Rabi & summer	Green	White	Curved	Curved	Smooth	Medium	Oblong	Creamish white	Pulse
9	LP-9	Bush	Green	Green	Present	White	Rabi & summer	Green	White	Curved	Curved	Wrinkled	Medium	Oval	Dark brown	Vegetable
10	LP-10	Semi viny	Light green	Light green	Present	White	Rabi	Green	White	Curved	Curved	Smooth	Medium	Oval	Light brown	Pulse
11	LP-11	Semi viny	Light green	Light green	Present	White	Rabi	Green	White	Curved	Curved	Smooth	Medium	Oval	Light brown	Pulse
12	LP-12	Semi viny	Green	Green	Present	White	Rabi	Light green	White	Curved	Curved	Smooth	Medium	Oval	Dark brown	Pulse
13	LP-13	Semi viny	Light green	Light green	Present	White	Rabi	Green	White	Curved	Curved	Smooth	Medium	Oval	Light brown	Pulse
14	LP-14	Semi viny	Light green	Light green	Present	White	Rabi	Green	White	Curved	Curved	Smooth	Medium	Oblong	Light brown	Pulse
15	LP-15	Semi viny	Light green	Light green	Present	White	Rabi	Light green	White	Curved	Curved	Smooth	Medium	Oval	Light brown	Pulse
16	LP-16	Bush	Green	Green	Present	White	Rabi & summer	Green	White	Curved	Curved	Wrinkled	Medium	Oblong	Dark brown	Vegetable
17	LP-19	Semi viny	Light green	Light green	Present	White	Rabi	Green	White	Curved	Curved	Smooth	Small	Oblong	Light brown	Pulse
18	LP-20	Semi viny	Green	Green	Present	Purple	Rabi	Light green	White	Curved	Curved	Smooth	Medium	Oval	Dark brown	Pulse
19	LP-21	Semi viny	Light green	Light green	Present	White	Rabi	Light green	White	Curved	Curved	Smooth	Small	Oval	Light brown	Pulse
20	LP-22	Semi viny	Light green	Light green	Present	White	Rabi	Light green	White	Curved	Curved	Wrinkled	Medium	Oval	Dark brown	Pulse
21	LP-23	Semi viny	Light green	Light green	Present	White	Rabi	Green	White	Curved	Curved	Smooth	Small	Oblong	Light brown	Pulse
22	LP-24	Semi viny	Light green	Light green	Present	White	Rabi	Light green	White	Curved	Curved	Smooth	Medium	Oval	Light brown	Pulse
23	LP-25	Semi viny	Light green	Light green	Present	White	Rabi	Green	White	Curved	Curved	Smooth	Medium	Oval	Light brown	Pulse
24	LP-26	Semi viny	Green	Green	Present	White	Rabi	Green	White	Curved	Curved	Smooth	Medium	Oval	Light brown	Pulse
25	LP-27	Bush	Light green	Light green	Present	White	Rabi	Green	White	Slightly curved	Slightly curved	Smooth	Big	Flat oval	Black	Pulse

Table 4. Vegetative characters

Accessions	Plant height (cm)	Plant spread (cm)	Number of primary branches	Leaf length (cm)	Leaf width (cm)	Pedicel length (cm)
LP-1	89.33	61.33	3.10	12.47	11.30	4.37
LP-2	98.00	82.13	2.00	8.60	7.27	2.40
LP-3	68.88	49.43	3.10	7.47	6.30	1.27
LP-4	147.07	87.93	4.10	7.63	8.40	2.90
LP-5	70.40	46.93	4.20	8.27	8.67	2.90
LP-6	64.07	38.37	2.87	12.27	11.47	5.27
LP-7	92.20	64.47	3.30	10.47	10.67	3.57
LP-8	71.43	51.80	4.67	7.73	8.53	4.23
LP-9	69.67	40.40	4.50	8.63	7.20	2.27
LP-10	110.30	82.10	3.00	10.20	8.50	2.37
LP-11	91.87	74.50	3.00	7.73	6.43	2.53
LP-12	131.00	91.53	3.10	9.57	8.37	2.10
LP-13	88.30	58.43	3.00	10.23	9.73	2.43
LP-14	93.40	51.33	3.00	10.97	8.30	2.40
LP-15	120.00	62.50	3.00	7.50	7.03	2.77
LP-16	81.73	37.40	3.73	10.80	8.60	3.37
LP-19	129.83	45.40	3.53	7.20	7.63	2.30
LP-20	134.87	66.47	3.00	8.50	7.43	3.10
LP-21	125.07	64.77	3.00	8.17	8.33	3.13
LP-22	134.97	70.10	4.00	8.47	7.40	3.23
LP-23	136.44	83.77	3.00	8.40	6.40	2.57
LP-24	124.43	87.20	3.00	7.43	8.40	3.13
LP-25	138.53	89.07	3.00	10.20	8.90	5.23
LP-26	104.87	49.73	4.00	7.27	7.00	2.33
LP-27	138.00	96.00	3.00	6.70	7.40	1.90

Plate - 2. Variability in lablab bean

LP - 3

LP - 4

LP - 5

Plate - 3. Variability in lablab bean

LP - 6

LP - 8

LP - 9

Plate - 4. Varibility in lablab bean

LP - 16

LP - 23

LP - 26

studied. The population mean, range, phenotypic coefficient of variation and genotypic coefficient of variation are given in table 9.

a) Plant height

Plant height varied from 64.07 cm (LP-6) to 147.07 cm (LP-4) with a mean of 104.86 cm. The pcv and gcv values were 25.50 and 25.14 respectively. There was significant difference between the accessions with respect to plant height.

b) Plant spread

Plant spread varied from 37.40 cm (LP-16) to 96.00 cm (LP-27) with a mean of 64.00 cm. The pcv and gcv were 27.22 and 27.19 respectively. There was significant difference between the accessions for plant spread.

c) Number of primary branches

Significant difference was found among the different accessions for the character. The accession LP-2 had minimum number of primary branches (2.00) and the accession LP-8 had the maximum number (4.67) with a mean of 3.34. The pcv value was 19.14 and gcv was 18.25.

d) Leaf length

Leaf length varied from 6.70 cm (LP-27) to 12.47cm (LP-1) with a mean of 9.00 cm. The pcv and gcv values were 17.63 and 17.51 respectively. There was significant difference between the accessions for leaf length.

e) Leaf width

Leaf width varied from 6.30 cm (LP-3) to 11.47 cm (LP-6) with a mean of 8.26 cm. The pcv and gcv values were 17.28 and 17.05 respectively. There was significant difference between the accessions.

Table 5: Flowering and maturity characters

Accessions	Days to first flowering	Days to 50 % flowering	Days to first harvest	Days to final harvest	Days to vegetable maturity	Pod setting percent (%)
LP-1	65.07	70.37	75.00	105.00	15.20	29.50
LP-2	63.40	68.87	73.00	93.00	14.56	39.80
LP-3	33.07	38.87	49.44	86.00	16.33	37.93
LP-4	30.53	51.07	61.66	123.00	16.40	38.00
LP-5	32.63	34.97	47.33	87.00	13.45	21.97
LP-6	44.63	37.97	49.22	81.00	15.89	33.80
LP-7	41.07	51.30	59.33	88.00	14.67	28.03
LP-8	31.30	48.53	57.66	86.00	16.50	28.30
LP-9	46.30	34.40	48.55	99.00	13.67	35.13
LP-10	44.53	53.07	62.00	101.00	19.67	27.23
LP-11	52.33	52.10	54.00	95.00	14.12	26.00
LP-12	40.60	57.30	58.00	98.00	16.67	27.37
LP-13	50.03	45.83	54.66	94.00.	17.10	20.53
LP-14	51.83	55.07	56.44	96.00	16.11	34.53
LP-15	52.63	55.67	57.20	102.00	19.60	29.63
LP-16	27.77	32.20	40.00	84.00	12.23	32.17
LP-19	53.53	57.87	58.33	103.00	18.67	31.43
LP-20	54.20	58.60	59.00	118.00	21.45	19.57
LP-21	56.00	60.43	60.00	106.00	21.78	24.83
LP-22	53.10	60.83	64.40	113.00	18.80	33.40
LP-23	55.10	58.00	60.00	109.00	24.47	28.53
LP-24	47.20	61.30	62.00	112.00	22.89	28.13
LP-25	47.20	59.33	59.30	114.00	21.12	22.13
LP-26	52.73	59.00	58.00	106.00	25.23	40.23
LP-27	59.00	69.00	68.00	118.00	23.00	25.00

f) Pedicel length

Pedicel length varied from 1.27 cm (LP-3) to 5.27 cm (LP-6) with a mean of 3.00 cm. The pcv and gcv were 32.43 and 31.77 respectively. There was significant difference between the accessions with respect to length of pedicel.

g) Days to first flowering

Analysis of variance for days to first flowering showed that there was a significant difference among the genotypes for this character. The value ranged from 27.70 (LP-16) to 65.07 (LP-1) with mean of 46.90. The pcv and gcv values were 22.39 and 21.27 respectively.

h) Days to 50 per cent flowering

Analysis of variance for days to 50 per cent flowering showed that there was a significant difference among the genotypes for this character. The value ranged from 32.20 (LP-16) to 70.37 (LP-1) with mean as 52.62. The pcv and gcv values were 20.16 and 19.81 respectively.

i) Days to first harvest

Days to first harvest varied from 40.00 (LP-16) to 75.00 (LP-1) with a mean of 58.10.

j) Days to final harvest

Days to final harvest varied from 81.00 (LP-6) to 123.00 (LP-4) with a mean of 111.5.

k) Days to vegetable maturity

Days to vegetable maturity varied from 12.23 (LP-16) to 25.23 (LP-26) with a mean of 19.10.

Table 6: Pod and seed characters

Accessions	Pod length (cm)	Pod girth (cm)	Pod thickness (cm)	Pod weight (g)	Shelling percent (%)	Number of seeds per pod	100 seed weight (g)
LP-1	6.90	2.80	0.21	2.53	57.10	5.10	24.30
LP-2	6.03	2.43	0.18	1.37	64.73	5.33	43.60
LP-3	8.47	4.07	0.30	2.57	82.27	3.87	34.67
LP-4	7.47	4.13	0.23	1.73	79.97	4.20	52.50
LP-5	8.80	3.57	0.24	1.73	74.00	5.00	29.80
LP-6	8.07	3.20	0.25	1.87	80.10	5.43	27.33
LP-7	7.63	4.13	0.17	1.37	86.57	4.87	22.50
LP-8	7.17	4.07	0.15	1.80	80.90	4.30	22.37
LP-9	8.90	3.97	0.34	3.03	86.13	5.77	32.57
LP-10	5.13	4.30	0.20	1.43	76.87	3.53	25.17
LP-11	6.50	2.70	0.32	1.47	55.53	3.10	24.47
LP-12	7.10	3.03	0.25	1.77	56.93	3.50	25.43
LP-13	7.70	2.97	0.16	1.37	65.67	3.50	27.47
LP-14	7.13	2.90	0.24	2.23	68.23	2.87	19.80
LP-15	7.93	2.97	0.34	2.77	71.83	2.87	24.67
LP-16	8.83	3.93	0.45	2.93	76.83	6.40	34.47
LP-19	6.37	3.07	0.21	2.43	63.17	3.87	23.80
LP-20	6.60	2.97	0.28	1.93	74.37	3.97	24.30
LP-21	6.40	2.67	0.16	1.87	71.30	3.63	20.68
LP-22	6.17	2.70	0.24	1.90	73.33	3.23	24.00
LP-23	6.70	2.77	0.20	2.10	62.63	3.10	21.00
LP-24	6.60	2.60	0.34	2.20	77.50	3.53	23.03
LP-25	6.57	2.47	0.33	2.33	65.30	4.30	23.57
LP-26	6.73	2.60	0.26	2.13	82.53	4.63	17.57
LP-27	9.98	5.47	0.40	4.61	60.72	6.00	37.39

l) Pod setting %

Analysis of variance for pod set revealed that there was significant difference between the different accessions under study. The lowest fruit set of 19.57 per cent was observed in the accession LP-20 and the highest pod set was observed in LP- 26(40.23%) with a mean value of 29.92 per cent. The pcv and gcv were 20.47 and 19.36 respectively.

m) Pod length

Pod length varied from 5.13 cm (LP-10) to 9.98 cm (LP-27) with a mean value of 7.16 cm. The pcv and gcv values were 13.94 and 13.37 respectively. There was significant difference between accessions for pod length.

n) Pod girth

The girth of pod ranged from 2.43 cm in LP-2 to 5.47 cm in LP-27 with a mean of 3.20cm. The value of pcv was 20.31 and that of gcv was 19.06. There was significant difference between accessions with respect to pod girth.

o) Thickness of pod

Pod thickness varied from 0.15 cm (LP-8) to 0.45 cm (LP-16) with a mean value of 0.25 cm. The pcv and gcv values were 30.82 and 28.41 respectively. There was significant difference between accessions for pod thickness.

p) Weight of pod

The different accessions varied significantly for weight of pod. Maximum pod weight was observed for the accession LP-27 (4.61 g) and minimum for LP-2, LP-7 and LP-13 (1.37 g). The pcv and gcv estimates were found to be 26.35 and 23.16 respectively.

Table 7: Yield and quality parameters

Accessions	Number of pods per plant	Yield per plant (kg)	Yield per plot (kg)	Crude protein (%)	Crude fibre (%)
LP-1	111.37	0.315	2.83	2.71	1.55
LP-2	131.00	0.360	3.07	2.56	1.32
LP-3	75.00	0.188	1.30	1.84	1.72
LP-4	198.27	0.363	3.33	2.21	1.94
LP-5	54.80	0.083	0.93	2.34	1.62
LP-6	64.47	0.150	1.33	1.60	2.23
LP-7	85.17	0.185	1.77	2.64	1.77
LP-8	81.63	0.156	1.60	2.21	1.54
LP-9	43.23	0.151	1.47	2.41	2.11
LP-10	55.40	0.106	0.97	2.02	1.34
LP-11	45.93	0.061	0.61	2.15	1.71
LP-12	55.40	0.144	1.07	2.13	1.62
LP-13	58.37	0.102	0.83	2.41	1.85
LP-14	63.13	0.167	1.53	2.35	1.55
LP-15	45.33	0.124	1.13	1.53	1.68
LP-16	65.87	0.238	2.13	2.34	2.14
LP-19	33.50	0.150	1.53	1.66	2.22
LP-20	71.93	0.173	1.47	1.77	2.17
LP-21	123.07	0.240	2.23	1.96	2.71
LP-22	126.53	0.246	2.47	2.26	1.15
LP-23	124.00	0.280	2.67	2.14	1.73
LP-24	114.93	0.240	2.77	2.54	1.30
LP-25	72.97	0.187	1.77	2.20	1.87
LP-26	227.33	0.553	4.50	2.04	1.54
LP-27	18.00	0.060	0.60	2.23	2.68

q) Number of pods per plant

Different accessions under study showed significant difference between them for number of pods per plant. The number of pods per plant ranged from 18.00 (LP-27) to 227.30 (LP-26). The mean pods per plant were 88.60. The pcv and gcv estimates were 54.80 and 54.30 respectively.

r) Pod yield plant $^{-1}$

The accession LP-27 recorded the lowest yield plant^{-1} (0.060 kg) and LP-26 recorded the highest yield plant^{-1}(0.553 kg).

s) Pod yield plot $^{-1}$

The yield of pods varied significantly among different accessions. The accession LP-27 had the lowest yield and LP-26 had the highest yield. Average yield per plot was 1.88 kg and the value ranged between 0.60 kg and 4.50 kg. The pcv and gcv estimates were 50.39 and 49.34 respectively.

t) Shelling %

The shelling percent was maximum for the accession LP-7 and minimum for LP-11. The values ranged between 55.53 per cent and 86.57 per cent with a mean of 72.24 per cent. The pcv and gcv estimates were 13.05 and 12.65 respectively. There was significant difference between accessions.

u) Number of seeds pod $^{-1}$

Maximum number of seeds pod $^{-1}$ was recorded for the accession LP-16 and minimum for LP-14 and LP-15. The values ranged between 2.87 and 6.40 with a

Table 8. Incidence of pests and disease

Pest/Disease	Susceptible accessions
Leaf eating caterpillars	LP-1, LP-4, LP-7, LP-8, LP-16, LP-26
Pod borers	LP-3, LP-7, LP-12, LP-13, LP-15, LP-20
Aphids	LP-5, LP-6, LP-8, LP-11, LP-15, LP-16
Cottony rot	LP-3, LP-27

Plate - 5. Variability in flower colour

Purple

White

Plate - 6. Sclerotia rot and aphid attack in lablab bean

Sclerotia rot

Aphid attack

mean value of 4.16. The pcv and gcv estimates were 24.05 and 22.84 respectively. Significant difference was noted between the different accessions.

v) Hundred seed weight

Hundred seed weight was maximum for the accession LP-4 (52.50g) and minimum for LP-26 (17.57g). The pcv and gcv values were 29.70 and 28.68 respectively.

w) Crude fibre content of pod

The crude fibre content of pods at edible maturity ranged from 1.15 per cent to 2.71 per cent, the mean value being 1.77 per cent. The accession LP-22 recorded the lowest fibre content and accession LP-21 had the highest fibre content. The pcv was 20.53 and gcv was 20.48. There was significant difference between the accessions in fibre content.

x) Crude protein content of pod

The crude protein content of pods at vegetable maturity stage was maximum for LP-1 and minimum for LP-15. It ranged between 1.53 and 2.71 per cent with a mean of 2.16. The pcv and gcv estimates were 14.84 and 14.81 respectively. There was significant difference between the accessions.

y) Pest and diseases

Mild incidence of cottony rot was noted in accessions LP-3 and LP-27 (Plate 6). Attack of leaf eating caterpillars and pod borers were very mild. Aphid infestation was observed to be mainly confined to the accessions LP-5, LP-6, LP-8, LP-11, LP-15 and LP-16 (Table 8).

4.2.2 Heritability, genetic advance and genetic gain

Heritability, genetic advance and genetic gain for different characters are presented in table 10.

Table 9. Range, mean, phenotypic coefficient of variation and genotypic coefficient of variation of different characters in lablab bean

SL. NO	Characters	Range	Mean+SE	pcv	gcv
1	Plant height (cm)	64.07-147.07	104.86+1.49	25.50	25.14
2	Plant spread (cm)	37.40-90.53	64.00+0.260	27.22	27.19
3	Number of primary branches	2.00-4.60	3.34+0.064	19.14	18.25
4	Leaf length (cm)	7.20-12.47	9.00+0.061	17.63	17.51
5	Leaf width (cm)	6.30-11.47	8.26+0.077	17.28	17.05
6	Pedicel length (cm)	1.27-5.27	3.00+0.065	32.43	31.77
7	Days to 1st flowering	27.70-63.40	46.95+1.09	22.39	21.27
8	Days to 50% flowering	32.20-70.30	56.62+0.65	20.16	19.81
9	Pod setting %	19.57-40.23	29.92+0.66	20.47	19.36
10	Pod length (cm)	5.13-8.90	7.16+0.093	13.94	13.37
11	Pod girth (cm)	2.43-4.30	3.20+0.074	20.31	19.06
12	Pod thickness (cm)	0.15-0.45	0.25+0.010	30.82	28.41
13	Pod weight (g)	1.37-3.03	2.03+0.085	26.35	23.16
14	Number of pods plant^{-1}	33.50-227.30	88.69+2.21	54.84	54.32
15	Yield plot^{-1} (kg)	0.60-4.50	1.88+0.064	50.39	49.34
16	Shelling %	55.53-86.57	72.24+0.77	13.05	12.65
17	Number of seeds pod^{-1}	2.87-6.40	4.16+0.104	24.05	22.84
18	100 seed weight (g)	17.57-52.50	27.04+0.60	29.70	28.68
19	Crude fibre (%)	1.15-2.71	1.76+0.0079	20.53	20.48
20	Crude protein (%)	1.53-2.71	2.16+0.0068	14.84	14.81

Table 10. Heritability, Genetic advance and Genetic gain for different characters in lablab bean

SL.No	Characters	Heritability (%)	Genetic advance	Genetic gain
1	Plant height (cm)	97.2	53.54	51.05
2	Plant spread (cm)	99.8	35.81	55.95
3	Number of Primary branches	90.9	1.20	35.92
4	Leaf length (cm)	98.6	3.23	35.88
5	Leaf width (cm)	97.4	2.86	34.62
6	Pedicel length (cm)	96.0	1.93	64.33
7	Days to 1st flowering	90.2	19.53	41.59
8	Days to 50% flowering	96.6	21.11	40.11
9	Pod setting %	89.4	11.28	37.70
10	Pod length (cm)	92.1	1.89	26.39
11	Pod girth (cm)	88.1	1.18	36.87
12	Pod thickness (cm)	85.0	0.14	56.00
13	Pod weight (g)	77.3	0.85	41.87
14	Number of pods plant^{-1}	98.1	98.31	110.84
15	Yield plot^{-1} (kg)	95.9	1.88	100.00
16	Shelling %	94.0	18.25	25.26
17	Number of seeds pod^{-1}	90.2	1.86	44.71
18	100 seed weight (g)	93.3	15.43	57.06
19	Crude fibre (%)	99.6	0.74	42.04
20	Crude protein (%)	99.6	0.66	30.55

Highest heritability was observed for the character plant spread (99.8%), followed by crude fibre and crude protein (99.6%). Other characters with high heritability were leaf length (98.6%), number of pods per plant (98.1%), leaf width (97.4%), plant height (97.2%), days to 50 per cent flowering (96.6%), pedicel length (96%), yield per plot (95.9%), shelling per cent (94%), 100 seed weight (93.3%), pod length (92.1%), number of primary branches (90.9%), days to 1st flowering, number of seeds per pod (90.2%), pod setting per cent (89.4%), pod girth (88.1%), pod thickness (85%) and pod weight (77.3%). Moderate and low heritability values were not there for the characters.

Genetic advance was highest for number of pods plant^{-1} (98.31) and lowest for thickness of pod (0.14).

Highest magnitude of genetic gain was manifested by number of pods plant^{-1} (110.84%) and the lowest by shelling per cent (25.26%). The characters like yield plot^{-1} (100%), pedicel length (64.3%), seed weight (57.06%), pod thickness (56%), plant spread (55.9%), plant height (51.05 %), number of seeds pod^{-1} (44.7%), crude fibre (42.04%), pod weight (41.87%), days to 1st flowering (41.5%), days to 50 per cent flowering (40.11%), pod setting per cent (37.7%), pod girth (36.8%), number of primary branches (35.92%), leaf length (35.88%), leaf width (34.62%), crude protein (30.55%) and pod length (26.39%) also had high genetic gain.

Moderate and low genetic gain was not observed for the characters.

4.2.3 Correlation

The genotypic and phenotypic correlations between different pairs of characters were estimated and presented in Table 11. It was observed that yield was significantly and positively correlated with pod setting per cent (rg = 0.565 and rp = 0.524) and number of pods plant^{-1} (rg = 0.330 and rp = 0.906) both

Table 11. Phenotypic and genotypic correlation coefficients between yield and its components

Characters	Setting %	Plant height	Primary branches	Plant spread	Days to 1st flowering	Days to 50% flowering	Pod length	Pod girth	Pod thickness	Pod weight	Pods/ plant	Yield/ pod	Seeds/ pod	100 seed weight	Shelling %	Crude fibre	Crude protein	Leaf length	Leaf width	Petiole length
Setting %		-0.165*	0.132	-0.208*	0.015	-0.025*	0.103	0.130	0.098	0.270	0.486*	0.565*	0.276	0.434*	0.335	-0.210*	0.010	-0.140*	-0.240*	-0.273*
Plant height	-0.165		-0.191	0.714*	0.143	0.642*	-0.604	-0.410	-0.049*	-0.095*	0.334	0.313	-0.531	-0.059*	-0.319*	0.00	-0.183*	-0.310*	-0.274*	-0.048*
Primary branches	0.103	-0.183		-0.414	-0.436	-0.467	0.414*	0.518*	0.105	0.272	0.131	0.108	0.267	0.049	0.499*	0.034	0.077	-0.287*	-0.065*	0.036
Plant spread	-0.196	0.704*	-0.396		0.061	0.623*	-0.630	-0.308*	-0.165*	-0.452	0.274	0.170	-0.472	0.108	-0.398	-0.368	0.200	-0.146*	-0.149*	-0.025*
Days to 1st flowering	0.011	0.133	-0.390	0.055		0.517*	-0.485	-0.634	-0.113*	-0.025*	0.170	0.357	0.117	-0.235*	-0.485	0.055	0.302	0.307	0.046	0.055
Days to 50% flowering	-0.013	0.623*	-0.442	0.631*	0.487*		-0.822	-0.684	-0.378	-0.232*	0.403*	0.455*	-0.429	-0.267*	-0.517	-0.324*	0.133	-0.082	-0.061*	0.060
Pod length	0.111	-0.568	0.374	-0.602	-0.445	-0.766		0.452*	0.430*	0.474*	-0.261*	-0.239*	0.495*	0.299	0.415*	0.310	0.025	0.109	0.146	-0.006*
Pod girth	0.140	-0.379	0.462*	-0.288	-0.538	-0.619	0.424		0.019	0.050	-0.201*	-0.279*	0.349	0.393*	0.646*	0.097	0.008	0.045	0.144	-0.121*
Pod thickness	0.076	-0.045	0.064	-0.149	-0.091	-0.336	0.377	-0.003		0.688*	-0.222*	-0.080*	0.235	0.111	0.135	0.090	-0.136	-0.061	-0.295*	-0.009*
Pod weight	0.245	-0.068	0.229	-0.395	-0.003	-0.201	0.411	0.028	0.620*		-0.160	0.104	0.252	-0.044*	0.148	0.249	-0.183*	-0.022*	-0.214*	-0.006*
Pods/plant	0.453*	0.324	0.120	0.272	0.163	0.387	-0.248	-0.195	-0.207	-0.141		0.950*	0.062	0.192	0.210	-0.186*	0.211	-0.248*	-0.094*	0.005
Yield/pod	0.524*	0.300	0.084	0.168	0.325	0.441	-0.230	-0.261	-0.068	0.085	0.906*		0.224	0.146	0.171	-0.172	0.282	-0.168*	-0.070*	0.067
Seeds/pod	0.245	-0.499	0.245	-0.449	0.121	-0.395	0.453	0.287	0.189	0.207	0.059	0.223		0.410*	0.388*	0.250	0.309	0.356	0.400*	0.353
100 seed weight	0.388	-0.056	0.045	0.102	-0.208	-0.255	0.287	0.348	0.107	-0.035	0.188	0.332	0.361		0.173	0.041	0.148	-0.094*	-0.060*	-0.172
Shelling %	0.301	-0.315	0.473*	-0.385	-0.438	-0.495	0.368	0.580*	0.110	0.121	0.207	0.157	0.353	0.156		0.092	-0.064	-0.143*	0.056	0.038
Crude fibre	-0.201	0.000	0.034	-0.367	0.050	-0.316	0.298	0.087	0.083	0.215	-0.184	-0.168	0.234	0.042	0.089		-0.431	0.065	0.135	0.164
Crude protein	0.008	-0.182	0.080	0.199	0.291	0.133	0.024	0.008	-0.126	-0.160	0.208	0.272	0.294	0.143	-0.056	-0.410		0.294	0.297	0.079
Leaf length	-0.130	-0.305	-0.273	-0.146	0.297	-0.080	0.109	0.056	-0.063	-0.026	-0.242	-0.162	0.341	-0.094	-0.145	0.062	0.291		0.791*	0.521*
Leaf width	-0.218	-0.267	-0.063	-0.145	0.043	-0.061	0.136	0.127	-0.248	-0.157	-0.091	-0.071	0.369	-0.061	0.060	0.134	0.295	0.770*		0.686*
Petiole length	-0.251	-0.047	0.032	-0.024	0.065	0.061	0.005	-0.108	-0.001	0.009	0.007	0.060	0.321	-0.161	0.036	0.162	0.079	0.510*	0.667*	

genotypically and phenotypically. Yield plant^{-1} was significantly and positively correlated with days to 50 per cent flowering (rg = 0.455) genotypically.

Significant and positive genotypic and phenotypic correlations are observed between pedicel length and leaf length (rg = 0.521 and rp = 0.510) and between pedicel length and leaf width (rg = 0.686 and rp = 0.667). But pedicel length was negatively correlated with pod setting per cent (rg = -0.273), plant height (-0.048), plant spread (-0.025), pod length (-0.006), pod girth (-0.121), pod thickness (-0.009) and pod weight (-0.006).

Significant and positive genotypic and phenotypic correlation was observed between leaf width and leaf length (rg = 0.791 and rp = 0.770) and with number of seeds pod^{-1}(0.400) genotypically. But significant negative genotypic correlation was observed between leaf width and pod setting per cent (-0.240), plant height (-0.274), number of primary branches (-0.065), plant spread (-0.149), days to 50 per cent flowering (-0.061), pod thickness (-0.295), pod weight (-0.214), number of pods plant^{-1} (-0.094), yield plot^{-1} (-0.070) and 100 seed weight (-0.060).

No significant positive correlation was observed between leaf length and other characters both genotypically and phenotypically. But significant negative correlation was observed with pod setting per cent (-0.140), plant height (-0.310), number of primary branches (-0.287), plant spread (-0.146), days to 50 per cent flowering (-0.082), pod thickness (-0.061), pod weight (-0.022), pods plant^{-1} (-0.248), yield plot^{-1} (-0.168), 100 seed weight (-0.094) and shelling per cent (-0.143).

With regard to shelling per cent, its correlation with number of primary branches (rg = 0.499 and rp = 0.473) and pod girth (rg = 0.646 and rp = 0.580) was significant and positive both genotypically and phenotypically. Its correlation with pod length (rg = 0.415) and number of seeds pod^{-1} (rg = 0.388) was significant and

positive genotypically. But its correlation with plant height (rg = -0.319) was significant and negative.

No significant positive correlation was observed between crude fibre, crude protein and other characters both phenotypically and genotypically.

No significant positive correlation was observed between 100 seed weight and other characters phenotypically. But significant positive genotypic correlation was observed with pod setting per cent (0.434), pod girth (0.393) and number of seeds pod^{-1} (0.410) and negative significant correlation was observed with plant height (rg = -0.059 and rp = -0.056), days to 1st flowering (rg = -0.235 and rp = -0.208), days to 50 per cent flowering (rg = -0.267 and rp = -0.255), pod weight (rg = -0.044 and rp = -0.035), leaf length (rg = -0.094 and rp = -0.094), leaf width (rg = -0.061 and rp = -0.060) and pedicel length (rg = -0.161 and rp = -0.172) both genotypically and phenotypically.

Significant positive genotypic correlation (0.495) was observed between number of seeds pod^{-1} and pod length. But no significant correlation was observed phenotypically between number of seeds pod^{-1} and other characters.

Significant positive correlation was obtained between number of pods $plant^{-1}$ and pod setting per cent (rg = 0.486 and rp = 0.453) both genotypically and phenotypically and with 50 per cent flowering (0.403) genotypically. But negative significant correlation was obtained between number of pods $plant^{-1}$ and pod length (rg = -0.261), pod girth (-0.201), pod thickness (-0.222) and pod weight (-0.160) genotypically.

With regard to pod weight, its correlation with pod thickness (rg = 0.688 and rp = 0.620) was positive and significant both phenotypically and genotypically and with pod length (rg = 0.474) it was positive and significant genotypically, but with

plant height (rg = -0.095), days to 1st flowering (rg = -0.025) and days to 50 per cent flowering (-0.232) it was negative and significant genotypically.

Significant positive correlation was obtained between pod thickness and pod length (rg = 0.474) genotypically, but significant negative correlation was obtained between pod thickness and plant height, plant spread and days to 1st flowering (rg = -0.049, -0.105 and -0.113 respectively).

Pod girth was significant and positively associated with number of primary branches (rg = 0.518 and rp = 0.462) both genotypically and phenotypically and with pod length (rg = 0.452) genotypically, but negatively associated with plant spread (rg = -0.308) genotypically.

Pod length was significantly and positively associated with number of primary branches (rg = 0.414) genotypically.

Days to 50 per cent flowering was significant and positively associated with plant height (rg = 0.642 and rp = 0.623), plant spread (rg = 0.623 and rp = 0.611) and days to 1st flowering (rg = 0.517 and rp = 0.487) both phenotypically and genotypically, but negatively associated with pod setting per cent (rg = -0.025) genotypically.

No significant correlation was observed between days to 1st flowering and other characters both genotypically and phenotypically.

Plant spread was significantly and positively associated with plant height (rg = 0.714 and rp = 0.704) both genotypically and phenotypically, but negatively associated with pod setting per cent (rg = -0.208) genotypically.

Table 12. Path coefficient analysis of pod yield and component characters.

Characters	Setting %	Plant height	Plant spread	Days to 1st flowering	Days to 50% flowering	Pod length	Pod girth	Pod thickness	Pod weight	Pods/ plant	Seeds/ pod	100 seed weight	Shelling %	Genotypic Correlation with yield
Setting %	0.149	-0.068	0.013	0.004	0.016	-0.018	0.012	-0.029	0.156	0.421	0.074	0.079	-0.052	0.565
Plant height	-0.025	0.415	-0.044	0.034	-0.419	0.105	-0.039	0.015	-0.055	0.289	-0.143	0.011	0.049	0.313
Plant spread	-0.031	0.296	-0.062	0.014	-0.407	0.109	-0.029	0.050	-0.262	0.238	-0.127	-0.020	0.062	0.170
Days to 1st flowering	0.002	0.059	-0.004	0.235	-0.338	0.084	-0.060	0.034	-0.014	0.148	0.031	0.043	0.075	0.357
Days to 50% flowering	-0.004	0.266	-0.038	0.122	-0.653	0.142	-0.065	0.113	-0.134	0.349	-0.115	0.049	0.080	0.455
Pod length	0.015	-0.251	0.039	-0.114	0.537	-0.173	0.043	-0.129	0.275	-0.226	0.133	-0.055	-0.064	-0.239
Pod girth	0.019	-0.170	0.019	-0.149	0.447	-0.078	0.095	-0.006	0.029	-0.174	0.094	-0.072	-0.100	-0.279
Pod thickness	0.015	-0.021	0.010	-0.026	0.247	-0.074	0.002	-0.299	0.399	-0.193	0.063	0.020	-0.018	-0.080
Pod weight	0.040	-0.040	0.028	-0.006	0.152	-0.082	0.005	-0.206	0.580	-0.138	0.068	0.008	-0.023	0.104
Pods/plant	0.073	0.139	-0.017	0.040	-0.264	0.045	-0.019	0.067	-0.092	0.866	0.017	-0.035	-0.033	0.930
Seeds/pod	0.041	-0.220	0.029	0.027	0.280	-0.086	0.033	-0.070	0.146	0.054	0.268	-0.075	-0.060	0.224
100 seed weight	0.065	-0.025	-0.007	-0.055	0.175	-0.052	0.037	-0.033	-0.025	0.167	0.110	-0.183	-0.027	0.146
Shelling %	0.050	-0.132	0.025	-0.114	0.338	-0.072	0.061	-0.034	0.086	0.182	0.104	-0.032	-0.155	0.171

Residual effect = -0.0355

Plant height and number of primary branches were significantly and negatively associated with pod setting per cent (rg = -0.165) and plant height (rg = -0.191) respectively, genotypically.

4.2.4 Path coefficient analysis

By partitioning the correlation between yield and component characters in to direct and indirect effects, the direct and indirect contribution of the component characters and yield can be found out. The results of the path coefficient analysis of 25 accessions of lablab bean for different characters are in table 12.

In path coefficient analysis highest positive direct effect on yield was exhibited by number of pods plant^{-1} (0.866) followed by pod weight (0.580). Direct effect of pod setting per cent on yield (0.149) and its correlation with yield was found to be positive (0.565).

Direct effect of plant height on yield was positive (0.415) and its.correlation with yield was found to be positive (0.313). Even though indirect effects of days to 50 per cent flowering (-0.419), number of seeds pod^{-1} (-0.143) was found negative.

Plant spread had direct negative (-0.062) effect on yield though days to 50 per cent flowering (-0.407), pod weight (-0.262) and number of seeds pod^{-1}(-0.127) were prominent, but its correlation with yield was found to be positive (0.170).

Direct effect of days to 1st flowering on yield was positive (0.235) and its correlation with yield was found to be positive (0.357).

Days to 50 per cent flowering had negative (-0.653) and very low direct effect on yield. Its indirect effects through pod girth (-0.065), pod weight (-0.134) and number of seeds pod^{-1} (-0.115) were prominent, but its correlation on yield was found to be positive (0.455).

Direct effect of pod length on yield was negative (-0.173). Its genotypic correlation with yield was also negative (-0.239) due to high negative indirect effects of plant height (-0.251), number of pods plant^{-1} (-0.226) and pod thickness (-0.129).

Pod girth had positive direct effect on yield (0.095). But its correlation with yield found to be negative (-0.279) through indirect effects like plant height (-0.170) and number of pods plant^{-1} (-0.174).

Direct effects of pod thickness on yield was negative (-0.299) its genotypic correlation with yield was also negative (-0.080) due to high negative indirect effects of number of pods plant^{-1} (-0.193) and pod length (-0.074).

Number of seeds pod^{-1} had positive (0.268) direct effect on yield and its correlation with yield was found to be positive (0.224).

High positive indirect effects of 50 per cent flowering (0.175) and number of pods plant^{-1} (0.167) were responsible for positive correlation coefficient between yield and 100 seed weight (0.146) even though the direct effect of 100 seed weight was negative (-0.183).

Direct effect of shelling per cent on yield was negative (-0.155) its genotypic correlation with yield was positive (0.171) due to high indirect effects of days to 50 per cent flowering (0.338), number of pods plant^{-1} (0.182) and number of seeds pod^{-1} (0.104).

Residual effect due to unknown factors on yield was -0.0355.

Table 13. List of lablab bean accessions in different clusters.

Cluster number	No. of accessions in each cluster	Accessions
I	7	LP-2, LP-10, LP-11, LP-12, LP-23, LP-24, LP-25
II	5	LP-1, LP-7, LP-13, LP-14, LP-22
III	4	LP-4, LP-20, LP-21
IV	6	LP-3, LP-5, LP-8, LP-9, LP-16, LP-26
V	3	LP-6, LP-15, LP-19, LP-27

Table 14. Means of variables for five clusters

Cluster number	Plant height	Plant spread	Primary branches	Leaf length	Leaf width	Pedicel length	Setting %	Pod length	Pod girth
I	118.65	84.18	2.87	8.87	7.75	2.9	28.45	6.37	2.9
II	99.64	61.13	3.28	10.52	9.48	3..2	29.19	7.1	3.1
III	135.67	73.05	3.36	8.1	8.05	3.04	27.46	6.82	3.25
IV	77.83	45.94	4.03	8.36	7.71	2.72	32.62	8015	3.7
V	104.63	48.75	3.13	8.99	8.71	3.44	31.62	7.45	3.08

Cluster number	Pod thickness	Pod weight	Pods/ plant	Yield/ plot	Shelling %	Seeds/ pod	100 seed weight	Crude fibre	Crude protein
I	0.26	1.81	85.66	1.84	65.64	3.77	26.61	1.55	2.24
II	0.20	1.88	88.91	1.39	70.18	3.91	23.61	1.57	2.47
III	0.22	1.84	131.09	2.34	51.21	3.93	32.49	2.27	1.98
IV	0.29	2.36	91.31	1.98	80.44	4.99	28.57	1.77	2.19
V	0.26	2.35	47.76	1.33	71.69	4.05	25.26	2.04	1.59

Table 15. Inter and Intra cluster D^2 values among five clusters of lablab bean

Clusters	I	II	III	IV	V
I	**1302.74**				
II	2448.82	**1391.94**			
III	3463.64	3788.51	**2677.62**		
IV	5734.18	3212.19	4106.13	**1645.21**	
V	8091.72	5747.72	4816.30	3423.93	**2416.12**

The values printed in bold indicates intra cluster D^2 values

4.2.5 Genetic divergence

Twenty five accessions of lablab bean were grouped in to 5 clusters using Mahalanobis D^2 statistics. The clustering pattern and the variable means of clusters are presented in table 13 and table 14.

Among 5 clusters, cluster number I had maximum number of accessions (7), cluster IV had 6 accessions, cluster II had 5 accessions, cluster V had 4 accessions and III had 3 accessions each.

Accessions included in cluster I were LP-2, LP-10, LP-11, LP-12, LP-23, LP-24 and LP-25 and it recorded highest mean value of plant spread (84.18cm) and lowest mean value of number of primary branches (2.87)and pod length (6.37cm).

Cluster II included accessions LP-1, LP-7, LP-13, LP-14 and LP-22 and they had a highest mean value of days to 1st flowering (52.21days) and mean yield plot^{-1} of (1.39 kg).

Cluster III which included LP-4, LP-20 and LP-21 had an highest mean value of plant height (135.67 cm) and mean pod yield plot^{-1} of (2.34 kg).

Accessions included in cluster IV were LP-3, LP-5, LP-8, LP-9, LP-16 and LP-26 and they had highest mean value for pod setting per cent (32.62%), number of primary branches (4.03) and pod length (8.15 cm) and mean pod yield of 1.98 kg plot^{-1}.

Accessions LP-6, LP-15, LP-19 and LP-27 were included in cluster V. which recorded lowest pod yield of 1.33 kg plot^{-1}.

Inter and intra D^2 values among the 5 clusters are given in table 15. Cluster III had maximum intra cluster value (2677.62) and cluster I the minimum

Table 16. Estimation of selection index

Sl.No	Accession No.	Selection index	Rank according to	
			Yield	Selection index
1	LP-26	6.332	1	1
2	LP-4	5.294	2	3
3	LP-2	4.916	3	4
4	LP-1	4.758	4	5
5	LP-24	4.519	5	6
6	LP-23	4.332	6	7
7	LP-22	5.552	7	2
8	LP-21	4.256	8	8
9	LP-16	3.944	9	9
10	LP-25	3.767	10	11
11	LP-7	3.792	11	10
12	LP-8	3.526	12	12
13	LP-19	3.297	13	16
14	LP-14	3.481	14	13
15	LP-20	3.479	15	14
16	LP-9	0.885	16	25
17	LP-6	3.233	17	18
18	LP-3	3.313	18	15
19	LP-15	3.048	19	20
20	LP-12	3.102	20	19
21	LP-10	2.887	21	21
22	LP-5	2.837	22	22
23	LP-13	2.800	23	23
24	LP-11	2.730	24	24
25	LP-27	3.250	25	17

(1302.74). The intra cluster distance for other clusters was 1391.94 (cluster II), 1645.21 (cluster IV) and 2416.12 (cluster V).

The maximum statistical distance was found between cluster I and V (8091.72) followed by cluster II and V (5747.72). The distance between the clusters I and II displayed the lowest degree of divergence (2448.82).

4.2.6 Selection index

Based on reliable and effective characters a selection index helps to select suitable genotypes from a mass population (Table 16).

Selection index involving the characters pod setting per cent, plant height, number of primary branches, plant spread, days to 1st flowering, days to 50 per cent flowering, leaf length, Leaf width, pedicel length, pod length, pod girth, pod thickness, pod weight, number of pods plant^{-1}, yield plot^{-1}, number of seeds pod^{-1}, 100 seed weight, shelling per cent, crude fibre and crude protein was selected for lablab bean to identify superior genotypes.

Based on selection index, the accession LP-26 was found to be most superior one followed by accessions LP-4, LP-2, LP-1, LP-24 and LP-23. Accession LP-26 was highest yielding accession with a mean yield of 4.5 kg plot^{-1}, mean number of pods plant^{-1} (217.6) and had maximum pod setting per cent (40.29). LP-4 was the accession with a maximum plant height of 147.1 cm and mean 100 seed weight (52.55 gm).

4.3 Seasonal effect

The experiment was conducted during two seasons viz., rabi and summer with twenty five accessions of lablab bean. During summer only nine accessions flowered due to photosensitivity, hence the data on flowering and pod characters of only nine accessions are available during second season (Plate 7 and 8). The data were analysed statistically. The results are presented in tables 17 to 23. On statistical analysis of the data, the treatments showed significant variation for all the characters except for days to 1st flowering, days to 50 per cent flowering, pod girth, pod thickness, number of pods plant^{-1} and 100 seed weight during rabi and summer seasons. The details are presented below.

a) Plant height

The character was found to vary significantly among treatments during both the seasons (Table17).

During rabi, plants of LP-4 produced tallest plants with 147.07 cm the shortest plant was obtained from LP-6 which recorded a height of 64.07 cm. During summer season also the tallest plant was obtained from the plants of LP-4 with 141.71 cm and the shortest plant (61.77 cm) was obtained from LP-6.

When seasonal effect was studied it was observed that plants were taller during rabi (83.86 cm) than summer (78.66 cm). The pooled analysis showed that LP-4 recorded the maximum plant height of 144.39 cm and the plant height was minimum (62.92 cm) in LP-6.

b) Plant spread

The character was found to vary significantly among treatments during both the seasons (Table17).

Plate - 7. Photosensitivity in lablab bean

LP - 26 during rabi

LP - 26 during summer

LP - 23 during rabi

LP - 23 during summer

Plate - 8. Photoinsensitivity in lablab bean

LP - 4 during rabi

LP - 4 during summer

Table 17. Seasonal performance of lablab bean (vegetative parameters)

Accessions	Plant height			Plant spread			No. Primary branches		
	Rabi	Summer	Mean	Rabi	Summer	Mean	Rabi	Summer	Mean
LP-1	89.33	72.66	81.00	61.33	54.38	57.86	3.10	3.59	3.11
LP-3	68.88	62.66	65.77	49.43	39.86	44.65	3.10	3.22	3.16
LP-4	147.07	141.71	144.39	87.93	72.95	80.40	4.10	4.00	4.05
LP-5	70.40	70.62	70.51	46.93	45.30	46.12	4.20	4.11	4.16
LP-6	64.07	61.77	62.92	38.37	34.28	36.31	2.87	2.78	2.82
LP-7	92.20	84.89	88.54	64.47	58.99	61.73	3.30	3.00	3.15
LP-8	71.43	71.11	71.27	51.80	43.56	47.68	4.67	4.11	4.39
LP-9	69.67	66.33	68.00	40.40	33.13	36.76	4.50	4.22	4.36
LP-16	81.73	76.22	78.98	37.40	24.79	31.09	3.73	3.78	3.76
Mean	83.86	78.66		53.12	45.24		3.73	3.59	
CD for treatments	11.6			7.03			0.65		
CD for treatments within year	15.78			9.94			0.93		

During rabi, the plant spread was maximum in LP-4 with 87.93 cm and the minimum was obtained from LP-16 which recorded a spread of 37.40 cm. During summer season also the maximum plant spread was obtained from the plants of LP-4 with 72.95 cm and the minimum was obtained from LP-16 with 24.79 cm.

When seasonal effect was studied it was observed that plant spread was more during rabi season (53.12 cm) than summer (45.24 cm). The pooled analysis showed that LP-4 recorded the maximum plant spread of 80.40 cm and the plant spread was minimum (31.09 cm) in LP-16.

c) Number of primary branches

The character was found to vary significantly among the accession during both the seasons (Table17).

The maximum number of branches were recorded by plants belonging to accession LP-8 (4.67) in rabi. The lowest number of branches were recorded for the plants of LP-6 (2.87). The plants of LP-9 recorded the highest number of branches (4.22) during summer.

When the seasons were compared it was observed that more number of branches were recorded during rabi season (3.73) than summer (3.59). On pooled analysis of data it was found that plants of LP-8 produced more number of branches (4.39), while LP-6 recorded the minimum number of branches (2.82).

d) Leaf length

The character was found to vary significantly among the accessions during both the seasons (Table 18).

During rabi, plants of LP-1 produced lengthy leaves with 12.47 cm and the shortest leaf was obtained from LP-3 which recorded a length of 7.47 cm. During

summer season also the longest leaves were obtained from the plants of LP-1 with 11.67 cm and the shortest leaf (6.90 cm) was obtained from LP-3.

On studying the seasonal effect, it was observed that leaves were longer during rabi season (9.53 cm) than summer (8.87 cm). The pooled analysis showed that LP-1 recorded the maximum leaf length of 12.07 cm and the leaf length was minimum (7.18 cm) in LP-3.

e) Leaf width

The character was found to vary significantly among the accessions during both the seasons (Table 18).

During rabi, the plants of LP-6 produced plants with maximum leaf width 11.47 cm and the minimum was obtained from LP-3 which recorded a width of 6.30 cm. During summer season, maximum width was obtained from the plants of LP-1 with 10.63 cm and the minimum width (5.97 cm) was obtained from LP-3.

It was observed that plants were having more leaf width during rabi season (9.01 cm) than during summer (8.58 cm). The pooled analysis showed that LP-1 recorded the maximum leaf width of 10.97 cm and the leaf width was minimum (6.13 cm) in LP-3.

f) Pedicel length

The character was found to vary significantly among the accessions during both the seasons (Table 18).

During rabi, LP-6 produced plants with maximum pedicel length of 5.27 cm and the minimum was obtained from LP-3 which recorded a length of 1.27 cm. During summer season also maximum pedicel length was obtained from the plants of LP-6 with 4.67 cm and the minimum length (1.17 cm) was obtained from LP-3.

Table 18. Seasonal performance of lablab bean (vegetative parameters)

Accessions	Leaf length			Leaf width			Pedicel length		
	Rabi	Summer	Mean	Rabi	Summer	Mean	Rabi	Summer	Mean
LP-1	12.47	11.67	12.07	11.30	10.63	10.97	4.37	3.87	4.12
LP-3	7.47	6.90	7.18	6.30	5.97	6.13	1.27	1.17	1.22
LP-4	7.63	7.50	7.57	8.40	8.23	8.32	2.90	1:87	2.38
LP-5	8.27	8.03	8.15	8.67	8.83	8.75	2.90	2.87	2.88
LP-6	12.27	11.53	11.90	11.47	10.03	10.75	5.27	4.67	4.97
LP-7	10.47	9.28	9.87	10.67	9.60	10.13	3.57	3.10	3.33
LP-8	7.73	7.47	7.60	8.53	8.57	8.55	4.23	3.97	4.10
LP-9	8.63	7.90	8.27	7.20	7.07	7.13	2.27	1.93	2.10
LP-16	10.80	9.53	10.17	8.60	8.27	8.43	3.37	3.00	3.18
Mean	9.53	8.87		9.01	8.58		3.35	2.94	
CD for treatments	1.19			1.55			0.87		
CD for treatments within year	1.68			2.19			1.23		

With reference to seasonal effect studies, it was observed that plants were having higher pedicel length during rabi season (3.35 cm) than during summer (2.94 cm). The pooled analysis showed that LP-6 recorded the maximum pedicel length of 4.97 cm and the pedicel length was minimum (1.22 cm) in LP-3.

g) Days to 1st flowering

There was no significant difference among the accessions for this character in rabi and summer (Table 19).

In rabi the plants of LP-4 flowered earlier (30.53days) where as in summer the number of days taken for flowering was lower for the accession LP-16 (25.55 days).

Seasonal variation was observed for days to 1st flower opening. During summer the plants flowered earlier (34.75 days) than rabi (41.91 days). Pooled analysis revealed that minimum number of days for opening of the 1st flower was in LP-5 (30.98 days).

h) Days to 50 per cent flowering

There was no significant difference among the accessions for this character in rabi and summer (Table 19).

In rabi the plants of LP-16 flowered earlier (32.20days). In summer also the number of days taken for flowering was lower for LP-16 (30.66 days).

Seasonal influence was observed for days to 50 per cent flower opening. During summer the plants flowered earlier (40.48 days) than rabi (44.41 days). Pooled analysis revealed that minimum number of days for opening of the 50 per cent flower was recorded by LP-16 (31.43 days).

Table 19. Seasonal performance of lablab bean (floral characters)

Accessions	Days to 1st flowering			Days to 50% flowering			Days to 1st harvest		
	Rabi	Summer	Mean	Rabi	Summer	Mean	Rabi	Summer	Mean
LP-1	65.07	48.11	56.59	70.37	55.67	63.02	75.00	62.22	68.61
LP-3	33.07	31.89	32.48	38.87	35.33	37.10	49.43	45.55	47.49
LP-4	30.53	43.77	37.15	51.07	50.11	50.59	61.67	57.66	59.67
LP-5	32.63	29.33	30.98	34.97	34.44	34.70	47.33	42.67	45.00
LP-6	44.63	33.00	38.82	37.97	37.66	37.81	49.20	46.00	47.60
LP-7	41.07	35.55	38.31	51.30	42.33	46.82	59.23	52.00	55.67
LP-8	31.30	37.55	34.43	48.53	43.44	45.99	57.67	52.00	54.83
LP-9	46.30	27.99	37.15	34.40	34.66	34.53	49.40	44.33	46.87
LP-16	52.63	25.55	39.09	32.20	30.66	31.43	40.00	37.00	38.50
Mean	41.91	34.75		44.41	40.48		54.34	48.83	
CD for treatments	N S			N S			8.97		
CD for treatments within year	N S			N S			12.68		

i) Days to 1st harvest

The character was found to vary significantly among the accessions during both the seasons (Table 19)

In rabi the plants of LP-16 were harvested earlier (40.00 days). In summer also the number of days taken for harvesting was lower for LP-16 (37.00 days).

Seasonal variation was also observed for days to 1st harvesting. During summer the plants could be harvested earlier (48.83 days) than rabi (54.34 days). Pooled analysis revealed that minimum number of days for harvesting was in LP-16 (38.50 days).

j) Pod length

The character was found to vary significantly among the accessions during both the seasons (Table 20).

During rabi, the plants of LP-9 produced longer pods of 8.90 cm. During summer season, the longer pods were obtained from the plants of LP-5 with 8.26 cm.

When seasonal effect was studied it was found that pods were lengthier during rabi season (8.03 cm) than during summer (7.28 cm). The pooled analysis showed that LP-5 possessed pods of maximum length (8.53 cm).

k) Pod girth

There was no significant difference among the accessions for this character both in rabi and summer (Table 20)

Table 20. Seasonal performance of lablab bean (Pod characters)

Accessions	Pod length			Pod girth			Pod thickness		
	Rabi	Summer	Mean	Rabi	Summer	Mean	Rabi	Summer	Mean
LP-1	6.90	6.29	6.59	2.80	2.39	2.59	0.21	0.17	0.19
LP-3	8.47	7.91	8.19	4.07	3.98	4.02	0.30	0.25	0.28
LP-4	7.47	6.91	7.19	4.13	3.96	4.05	0.23	0.19	0.21
LP-5	8.80	8.26	8.53	3.57	3.16	3.36	0.24	0.25	0.25
LP-6	8.07	7.12	7.60	3.20	2.95	3.08	0.25	0.19	0.22
LP-7	7.63	6.69	7.16	4.13	3.64	3.89	0.17	0.14	0.16
LP-8	7.17	6.88	7.02	4.07	3.32	3.69	0.15	0.17	0.16
LP-9	8.90	7.66	8.28	3.97	3.59	3.78	0.34	0.27	0.30
LP-16	8.83	7.77	8.30	3.93	3.15	3.54	0.45	0.38	0.42
Mean	8.03	7.28		3.76	3.35		0.26	0.22	
CD for treatments	0.68			N S			N S		
CD for treatments within year	0.97			N S			N S		

During rabi, plants of LP-4 produced pods with maximum girth (4.13 cm) and during summer, maximum pod girth was obtained from the plants of LP-3 with 3.98 cm.

There was not much difference between seasons as the average pod girth was 3.76 cm and 3.35 cm during rabi and summer respectively. The pooled analysis showed that LP-4 beared pods with maximum girth (4.05 cm).

l) Pod thickness

There was no significant difference among the accessions during both the seasons (Table 20).

During rabi and summer plants of LP-16 produced pods with maximum thickness of 0.45 cm and 0.38 cm respectively.

Between seasons there was not much difference as the average pod thickness was 0.26 cm and 0.22 cm during rabi and summer respectively. The pooled analysis showed that LP-16 recorded the maximum pod thickness of 0.42 cm.

m) Pod setting %

The character was found to vary significantly among the accessions during both the seasons (Table 21).

During rabi and summer plants of LP-4 had higher pod setting per cent of 38.00 and 23.01 respectively.

On studying the seasonal effect, it was observed that plants had higher pod setting per cent during rabi season (31.65) than during summer (16.84). The pooled analysis showed that LP-4 recorded the maximum pod setting per cent of 30.50.

Table 21. Seasonal performance of lablab bean (Pod characters)

Accessions	Pod setting %			Pod weight		
	Rabi	Summer	Mean	Rabi	Summer	Mean
LP-1	29.50	13.37	21.44	2.53	2.20	2.37
LP-3	37.93	21.67	29.80	2.57	2.68	2.63
LP-4	38.00	23.01	30.50	1.73	1.86	1.80
LP-5	21.97	11.23	16.60	1.73	1.48	1.60
LP-6	33.80	11.25	22.53	1.87	1.97	1.92
LP-7	28.03	10.35	19.19	1.37	1.75	1.56
LP-8	28.30	16.17	22.23	1.80	1.88	1.84
LP-9	35.13	21.70	28.42	3.03	3.05	3.04
LP-16	32.17	22.85	27.51	2.93	2.99	2.96
Mean	31.65	16.84		2.17	2.21	
CD for treatments	6.12			0.70		
CD for treatments within year	9.64			1.00		

n) Pod weight

Among the accessions the character pod weight varied significantly during both the seasons (Table 21)

During rabi and summer, plants of LP-9 produced pods with maximum weight of 3.03g and 3.05g respectively.

On comparing the seasons, there was not much difference as the average pod weight was 2.17 g and 2.21 g during rabi and summer respectively. On pooled analysis, it was observed that the plants of LP-9 produced pods with maximum weight (3.04 g).

o) Number of pods plant^{-1}

There was no significant difference among the accessions for this character in rabi and summer (Table 22).

In rabi, the plants under LP-4 recorded higher number of pods plant^{-1} (198.27). In summer also the plants under LP-4 recorded higher number of pods plant^{-1} (45.47).

Seasonal variation was also manifested for the number of pods plant^{-1} and it was more during rabi (86.64) than summer (26.16). Pooled analysis revealed that number of pods plant^{-1} was maximum from LP-4 with 121.87 pods.

p) Yield plant^{-1}

The character was found to vary significantly among the accessions during both seasons (Table 22).

During rabi LP-4 recorded the highest yield of 0.36 kg plant^{-1}. In summer also LP-4 recorded the highest yield of 0.11 kg plant^{-1}.

Table 22. Seasonal performance of lablab bean (Yield characters)

Accessions	No. pods plant^{-1}			Yield plant^{-1}			Yield plot^{-1}		
	Rabi	Summer	Mean	Rabi	Summer	Mean	Rabi	Summer	Mean
LP-1	111.37	30.50	70.93	0.31	0.07	0.19	2.83	0.76	1.30
LP-3	75.00	32.40	53.70	0.18	0.10	0.14	1.30	0.97	1.13
LP-4	198.27	45.47	121.87	0.36	0.11	0.23	3.33	1.15	2.24
LP-5	54.80	11.20	33.00	0.08	0.03	0.06	0.93	0.35	0.64
LP-6	64.67	19.13	41.80	0.15	0.04	0.10	1.33	0.49	0.91
LP-7	85.17	24.37	54.77	0.18	0.05	0.11	1.77	0.46	1.11
LP-8	81.63	25.57	53.60	0.15	0.06	0.10	1.60	0.64	1.12
LP-9	43.23	20.33	31.78	0.15	0.07	0.11	1.47	0.72	1.10
LP-16	65.87	26.43	46.15	0.23	0.09	0.16	2.13	0.98	1.56
Mean	86.64	26.16		0.20	0.07		1.86	0.72	
CD for treatments	N S			0.20			1.87		
CD for treatments within year	N S			0.29			2.15		

On comparing both the seasons it was observed that pod yield plant^{-1} was higher (0.20 kg) during rabi than summer (0.07 kg). Mean yield plant^{-1} over two seasons was maximum in the accession LP-4 (0.23 kg).

q) Yield plot^{-1}

The accessions varied significantly for the pod yield plot^{-1} and the character varied significantly among the accessions during both the seasons (Table 22).

In rabi, the plants of LP-4 recorded the maximum pod yield plot^{-1} of 3.33 kg. During summer also the plants of LP-4 recorded the maximum yield of 1.15 kg plot^{-1}.

Seasonal variation was noticed for this character. During rabi a higher plot yield of 1.86 kg was recorded while in summer 0.72 kg plot^{-1} was recorded. Mean yield plot^{-1} over two seasons was maximum in the accession LP-4 (2.24 kg).

r) Number of seeds pod^{-1}

The character varied significantly among the accessions during both the seasons (Table 23).

During rabi, maximum number of seeds (6.40) was observed in pods from LP-16. During summer also pods from LP-16 recorded highest number of seeds (6.11).

Higher number of seeds were present during rabi (4.99) than during summer (4.52). Pooled analysis revealed that maximum number of seeds pod $^{-1}$ was obtained from LP-16 (6.25).

s) Hundred seed weight

There was no significant difference among the accessions for this character in rabi and summer (Table 23).

Table 23. Seasonal performance of lablab bean (Seed characters)

Accessions	No. seeds pod^{-1}			100 seed weight			Shelling %		
	Rabi	Summer	Mean	Rabi	Summer	Mean	Rabi	Summer	Mean
LP-1	5.10	4.00	4.55	24.30	26.31	25.30	57.10	54.60	55.85
LP-3	3.87	3.89	3.88	34.67	39.39	37.03	82.27	79.19	80.73
LP-4	4.20	4.89	4.54	52.50	49.19	50.85	79.97	79.59	79.78
LP-5	5.00	5.00	5.00	29.80	27.46	28.63	74.00	74.70	74.35
LP-6	5.43	4.22	4.86	27.33	29.83	28.58	80.10	83.58	81.84
LP-7	4.87	3.88	4.38	22.50	22.34	21.92	86.57	84.11	85.34
LP-8	4.30	4.33	4.31	22.37	26.02	24.19	80.90	83.50	82.20
LP-9	5.77	4.35	5.05	32.57	32.99	32.78	86.13	83.20	84.66
LP-16	6.40	6.11	6.25	34.47	34.44	34.46	76.83	73.81	75.32
Mean	4.99	4.52		31.17	31.89		78.21	77.36	
CD for treatments	2.14			N S			6.17		
CD for treatments within year	3.03			N S			8.73		

Seeds of maximum weight were obtained from pods of LP-4 with an average hundred seed weight of 52.50 g during rabi season, in summer also the seasonal variation was meager (49.19g).

The average seed weight was 31.17 g and 31.89 g during rabi and summer respectively. On pooled analysis, it was observed that the pods of LP-4 produced seeds with maximum weight (50.85 g).

t) Shelling %

Significant variation was observed among the accessions for the character, shelling per cent during both the seasons (Table 23).

During rabi and summer seasons the pods of accession LP-7 recorded higher shelling per cent of 86.57 and 84.11 respectively.

During rabi the average shelling per cent was 78.21 where as in summer it was slightly lower with 77.36.

Based on the above results, it was confirmed that the over all performance of the crop was better during rabi than summer, in terms of productivity of the crop.

Discussion

5. DISCUSSION

The history of crop improvement begins with the early days of mankind changing his mode of life from a nomad to an agriculturist. The challenge for present day breeders is to develop varieties with high production potential coupled with better quality, which is stable across a range of environments. Of late, yielding stability as a selection trait is perpetually gaining importance over yielding ability. Consequently development of suitable genotypes that are stable to target environment with less interaction is an important objective of the scientific community.

India is endowed with a wealth of germplasm of lablab bean comprising many local cultivars, wild and weedy forms, but very little attention has been paid for the improvement of this crop. Knowledge about nature and magnitude of variation among the cultivars, heritability of different economic traits and association between different characters is essential for the success of any crop improvement programme.

In the present study, accessions of lablab bean collected from different parts of the country were evaluated for variability, heritability, genetic gain, genetic divergence and correlation among yield and its component characters. The results are discussed here under.

5.1 Genetic Cataloguing in lablab bean

Twenty five *Lablab purpureus* accessions collected from different sources were catalogued for morphological characters using the NBPGR descriptor list for lablab bean. Success of any breeding programme depends basically on the extent of variability available in the base population. Wide range of variation was observed in collected germplasms. Pod colour ranged from light green, green to purple. Seed size ranged from small, medium to big. Variations in flower colour, pod surface pod shape and seed colour were also observed. This high variability in morphological characters

points towards the aptness of the suggestion that India is the centre of origin for lablab bean (Rai and Yadav, 2005).

5.2 Variability

The success of any crop improvement programme depends upon the precise information available on the genetic variability of the crop.

In the present study, significant differences among the genotypes for the characters such as plant height, plant spread, number of primary branches, leaf length, leaf width, pedicel length, days to 1st flowering, days to 50 per cent flowering, pod setting per cent, pod length, pod girth, pod thickness, pod weight, number of seeds pod^{-1}, number of pods $plant^{-1}$, yield $plot^{-1}$, 100 seed weight, shelling per cent, crude fibre and crude protein were noticed. The existence of considerable variation indicated enough scope for improvement. Variability in many of the economic characters in this crop had been observed by many earlier workers like Nayar (1982), Biju (2000), Singh *et al.* (2004) and Singh and Singh (2006).

Plant height, plant spread, number of primary branches, leaf length, leaf width and pedicel length had high pcv than gcv suggesting the influence of environment on these characters. For all the six characters, gcv was very nearer to pcv and hence effect of genotype on phenotypic expression was also high. Earlier Biju (2000) reported that almost all the characters had higher pcv than gcv.

High environmental effects on phenotype for the characters like days to 1st flowering, days to 50 per cent flowering, pod setting per cent, pod length and pod girth were evident from their higher pcv as compared to gcv. Days to 1st flowering and days to 50 per cent flowering are considered as indices of earliness. The accession LP-16 was found to be the earliest flowering accession, which produced 1st flowers in 27.70 days. Earlier Veerabadhiran *et al.* (2006) reported production of 1st flowers in 48 days and Murthy and Kumar (2004) in 58 days.

Number of pods plant^{-1} and yield plot^{-1} had high gcv and pcv indicating maximum variability among different accessions and hence the scope for effective selection. This result is in agreement with that of Vaid and Singh (1983), Rajput *et al.* (1994) and Biju (2000) in lablab bean. Very high variability for number of pods plant^{-1} was also reported by Biju (2000), Singh *et al.* (2004) and Singh and Singh (2006).

Pod thickness, pod weight, number of seeds pod^{-1}, 100 seed weight, shelling per cent, crude fibre and crude protein were found to be influenced by environment as indicated by higher pcv (30.82, 26.35, 24.05, 29.70, 13.05, 20.53 and 14.84 respectively) compared to gcv (28.41, 23.16, 22.84, 28.68, 12.65, 20.48 and 14.81 respectively). Maximum range of variation was observed for number of seeds pod^{-1} (2.87-6.40). The pcv and gcv were also high for this trait suggesting very high variability and scope for effective selection. These findings were in accordance with the findings of, Desai *et al.* (1996), Chetia *et al.* (2000), Alkari *et al.* (2006) and Veerabadhiran *et al.* (2006).

5.3 Heritability

High heritability value indicates that the character is least affected by environment and low heritability value indicates high influence of the environment. If the effect of environment is high, genetic improvement through selection will be difficult due to masking effects of environment on genotype. Presence of additive genes is indicated by high genetic advance and genetic gain.

Results of the present study revealed that among the characters, crude fibre, number of pods plant^{-1} and yield plot^{-1} exhibited high heritability (99.60, 98.0 and 95.90 respectively) and genetic gain (42.04, 110.84 and 100.00 respectively) indicating that these characters were least affected by environment. This revealed that variation for the above characters was mainly due to the action of additive genes and these traits can be improved by selection, hence there is ample scope for selection.

The heritability estimates though provide the basis for selection on the phenotypic performance, Johnson *et al.* (1955) suggested that the estimates of heritability and expected genetic advance should always be considered jointly. The results of this study are comparable with that of Rathnaiah (1982) and Newaz (1990).

All the characters studied indicated high heritability values and the plant spread showed the highest heritability estimates. The genetic gain was the lowest for the character shelling per cent (25.26). The genetic gain for rest of the characters was fairly high. High heritability estimates with low genetic gain for the characters like pod length, shelling per cent and crude protein suggested that non additive type of gene action and genotype x environment (G x E) interaction might have played a significant role in the expression of these traits. This is in conformity with the findings of Uddin and Newaz (1997) and Ampily (2005).

Effective selection can be made using crude fibre, number of pods plant^{-1} and yield plot^{-1}. These findings are in agreement with that of Singh *et al.* (1985) and Singh and Singh (2006).

5.4 Correlation

Yield is a complex character contributed by many related components. Hence knowledge of the relationship of yield and its component characters is essential for the simultaneous improvement of yield components and in turn for the yield increase to be effective.

In the present study yield was found to be significantly and positively correlated with pod setting per cent and number of pods plant^{-1} genotypically and phenotypically and with days to 50 per cent flowering genotypically. Correlation between number of pods plant^{-1} and yield in lablab bean was reported by earlier workers like Uddin and Newaz (1997), Biju *et al.* (2001), Bagade *et al.* (2004), Rai *et al.* (2004), and Aher *et al.* (2006).

Genotypic correlation between yield and pod setting per cent and between yield and number of pods plant^{-1} was higher than phenotypic correlation which indicated the presence of strong association between these characters and yield. Low phenotypic correlation can be attributed to the smaller effects of environment. Higher phenotypic correlation between number of pods plant^{-1} and yield and between pod setting per cent and yield revealed that its association with yield was not only due to genes but also due to favourable influence of environment.

Yield was found to be positively correlated with plant height, number of primary branches, plant spread, days to 1st flowering, pod weight, number of seeds pod^{-1}, 100 seed weight, shelling per cent, crude protein and pedicel length and negatively correlated with pod length, pod girth, pod thickness, crude fibre, leaf length and leaf width. However these correlations were found to be insignificant indicating the independent nature of these characters in relation to yield.

In general, for almost all characters, genotypic correlation was found to be higher than phenotypic correlation indicating that environment had smaller effect on these characters.

Pod setting per cent was found to be positively and significantly correlated with number of pods plant^{-1} and 100 seed weight which revealed that when pod setting per cent is more number of pods plant^{-1} and 100 seed weight will also be more.

Plant height was significantly and positively correlated with plant spread and days to 50 per cent flowering. This indicated that when plant spread is more, the spread will also be more with early flowering nature.

Days to 50 per cent flowering was significantly and positively correlated with number of pods plant^{-1} and yield plot^{-1}. Thus earliness could be related to production of more number of pods and high yield.

Positive, significant correlation between pod length, pod girth, pod thickness, pod weight, number of seeds pod^{-1} and shelling per cent indicated that the higher the pod length, the higher will be its girth, weight, number and shelling per cent. Positive and significant correlation between pod length and number of seeds pod^{-1} was also reported by Singh (1993).

Pod girth was significantly and positively correlated with 100 seed weight and shelling per cent, which showed that when pod girth increased, 100 seed weight and shelling per cent also increased.

Yield plot^{-1} was found to increase when number of pods plant^{-1} increased as indicated by significant positive correlation between these characters. These findings were in agreement with Nath and Korla (2004).

Significant positive correlation between leaf length, leaf width and pedicel length indicated that when leaf length increased, leaf width and pedicel length also increased.

Thus it can be inferred that for increasing yield, the characters to be considered are number of pods plant^{-1} and pod setting per cent which are also positively correlated among themselves and with yield plot^{-1} and 100 seed weight. This is in confirmation with the findings of Uddin and Newaz (1997) and Biju (2000).

5.5 Path analysis

The path coefficient analysis provides an effective measure of untangling direct and indirect cause of association and permits a critical examination of specific causes acting to produce a given correlation and measures the relative importance of each factor.

On partitioning of the correlation into direct and indirect effects, it was observed that pod setting per cent, plant height, days to 1st flowering, pod girth, pod weight, number of pods plant^{-1} and number of seeds pod^{-1} had high direct positive effects on yield and number of primary branches, plant spread, days to 50 per cent flowering, pod length, pod thickness, 100 seed weight and shelling per cent exhibited high negative direct effect on yield. It revealed a true relationship between these characters and yield and hence direct selection for these traits would be rewarding for yield improvement.

The direct effect of pod setting per cent on yield and correlation coefficient was positive and also there was direct effect of plant spread, days to 1st flowering, days to 50 per cent flowering, pod girth, pod weight, number of pods plant^{-1}, number of seeds pod^{-1} and 100 seed weight. Hence direct selection via these characters should be considered.

The direct effect of plant height on yield and correlation coefficient was positive and also there was direct effect of number of primary branches, days to 1st flowering, pod length, pod thickness, number of pods plant^{-1}, 100 seed weight and shelling per cent, hence direct selection via these characters should be considered. This is in agreement with the reports of Tikka *et al.* (2003).

Days to 50 per cent flowering exhibited negative direct effect on yield, while correlation coefficient was positive. This emphasizes the need for selection of days to 50 per cent flowering through plant height, number of primary branches, days to 1st flowering, pod length, pod thickness, number of pods plant^{-1}, 100 seed weight and shelling per cent.

Pod length and pod thickness exhibited negative correlation with yield, though the direct effect of pod girth on yield was positive. But correlation coefficient was found to be negative, due to high indirect effects of number of primary branches, days

to 1st flowering and number of pods plant^{-1}. Hence indirect selection via all these characters should be considered. Kumari *et al.* (2003) also reported negative correlation for pod length with yield.

Number of pods plant^{-1}, pod weight, number of seeds pod^{-1} and days to 1st flowering exhibited high direct effect on yield and their correlation coefficient with yield was also positive. Hence direct selection can be done for these characters. High direct effects of number of pods plant^{-1} (Bagade *et al.*, 2004), number of pods plant^{-1} and pod weight (Rai *et al.*, 2004) and number of pods plant^{-1} and number of seeds pod^{-1} (Tikka *et al.*, 2003) have also been reported in lablab bean.

Number of primary branches, plant spread, 100 seed weight and shelling per cent even though had negative direct effect, correlation coefficient was positive. This emphasizes the need for selection of number of primary branches, 100 seed weight and shelling per cent through days to 50 per cent flowering and plant spread through plant height.

5.6 Genetic divergence

The multivariate analysis using Mahalanobis D^2 statistics is a valuable tool for obtaining quantitative estimates of divergence between biological populations. Genetically divergent parents are essential to generate new variability and desirable recombinants. In the present study, the 25 accessions of lablab bean were grouped into five clusters, indicating considerable genetic diversity prevailing among them. Genotypes belonging to same place were distributed among different clusters, thus ruling out the association between geographical distribution of genotypes and genetic divergence which supports the earlier observations of Sobha (1996) and Golani *et al.* (2006).

Analysis of intercluster distance revealed that the genetic divergence was maximum between cluster I and cluster V (8091.72), followed by cluster II and

more stable and reliable since the selection index value was calculated considering other yield contributing factors also. Selection through index values in vegetables was also reported by Mathew (1999) and Cherian (2000).

Accession LP-26 identified as the most superior one was found to be the highest yielding accession with an average yield of 4.50 kg plot^{-1}. It took 52.73 days for flowering and produced an average of 227.33 pods plant^{-1}. Accession LP-4 with an average yield of 3.33 kg plot^{-1} took 30.35 days for flowering and produced an average of 198.27 pods plant^{-1}. LP-2 was the next high yielding accession with 3.07 kg plot^{-1} and it flowered in 63.40 days, producing on an average 131.00 pods plant^{-1}.

Thus the study revealed that the accessions LP-26, LP-4 and LP-2 were the most promising ones.

5.8 Seasonal effect

Seasonal variation observed for the characters were discussed here under.

In the present study, out of twenty five accessions only nine accessions flowered during summer. This may be due to photoinsensitive nature of those accessions. Existence of photosensitivity in lablab bean was earlier reported by Shivashankar *et al.* (1993), Peter (1998) and Thamburaj and Singh (2003).

Significant differences between the accessions were noted for the characters namely plant height, plant spread, number of primary branches, days to 1st harvest, leaf length, leaf width, pedicel length, pod setting per cent, pod length, pod weight, number of seeds pod^{-1}, yield plot^{-1} and shelling per cent. Days to 1st flowering, days to 50 per cent flowering, pod girth, pod thickness, number of pods plant^{-1} and 100 seed weight were non significant.

cluster V (5747.72). The intercluster distance between cluster I and cluster II was low (2448.82) suggesting less genetic divergence among them compared to other clusters.

Hybridization between genotypes of cluster I and V, II and V is likely to give high heterosis for yield attributes due to high divergence between these clusters.

Cluster III exhibited the highest yield plot^{-1} (2.34 kg) followed by cluster IV (1.98 kg). Maximum number of pods plant^{-1} (131.09) was recorded by cluster III while minimum (47.76) by cluster V. Maximum pod length (8.15 cm) was recorded by cluster IV followed by cluster V (7.45 cm), while cluster II had maximum days for 1st flowering (52.21 days) and minimum (41.44) by cluster IV. Cluster IV had maximum fruit setting per cent (32.62 per cent).

5.7 Selection index

A better way to exploit genetic correlation with several traits having high heritability is to construct an index, called selection index, which combines information on all the characters associated with yield. This technique provides information on yield components and thus aids in indirect selection for the improvement of yield.

The selection index involving all the yield components namely plant height, plant spread, number of primary branches, leaf length, leaf width, pedicel length, days to1st flowering, days to 50 per cent flowering, pod setting per cent, pod length, pod girth, pod thickness, pod weight, number of seeds pod^{-1}, number of pods plant^{-1}, yield plot^{-1}, 100 seed weight, shelling per cent, crude fibre and crude protein was observed to have the maximum efficiency compared to direct selection based on yield. Smith (1936) model with all the yield components was selected for ranking the genotypes. Ranking based on selection index showed that LP-26 was the most superior one followed by LP-4 and LP-2. It indicated that superiority of these genotypes were

Results for all the characters except pod weight and 100 seed weight was better during rabi than summer.

Based on the above results, it was confirmed that the performance of lablab bean was better during rabi than during summer in terms of productivity. The high temperature, water stress and long days prevailing in summer might be the factors leading to the lesser performance of the crop during this season.

Twenty five accessions of lablab bean collected from different parts of India were genetically catalogued based on the descriptor for lablab bean. Accession LP-26 (a pulse type) had maximum yield of 4.50 kg plot^{-1}. It produced 227.33 pods plant^{-1} with maximum pod setting per cent of 40.23. This was followed by accession LP-4 (a vegetable type) with an average yield of 3.33 kg plot^{-1} and 198.27 pods plant^{-1}. Earliness (27.77 days) and highest number of seeds pod^{-1} (6.40) was shown by the accession LP-16 (a vegetable type).

The qualitative characters like crude protein and crude fibre content was found to be highest in accessions LP-1 and LP-21 respectively. Correlation studies revealed strong association between yield and the traits like pod setting per cent and number of pods plant^{-1}. Results of path coefficient analysis brought out that number of pods plant^{-1} had the highest positive direct effect on yield followed by pod weight. The genotypes were grouped into five clusters based on genetic distance. Comparison of different genotypes based on the selection index revealed the superiority of the genotype LP-26 for rabi season and LP-4 for both summer and rabi season.

Summary

6. SUMMARY

The present study on "Performance analysis of bush lablab bean (*Lablab purpureus* (L.) Sweet)" was carried out in the Department of Olericulture, College of Horticulture, Vellanikkara, during 2006 – 2007.

The programme envisaged cataloguing of available germplasm in lablab bean; assessment of genetic variability and divergence; assessment of association of different traits with yield including the direct and indirect effects of traits on yield and formulation of a selection index to identify superior genotypes.

Field experiment was laid out in RBD with three replications and the experimental material consisted of 25 accessions of lablab bean from different parts of India. Observations on different quantitative and qualitative characters were recorded in each replication. The data were subjected to suitable statistical analysis, so as to estimate the variability of genotypes. The salient findings of the study are summarized below.

1. Twenty five accessions of lablab bean collected from different parts of India were genetically catalogued based on the descriptor listed for lablab bean. Wide variations for pod shape, pod colour and other vegetative, flower and seed characters were noted. Pod colour varied between light green, green and purple. Pods were either curved or slightly curved in shape. Seed colour was found to be black, dark brown, light brown and creamish white. Accessions were pulse or vegetable type according to their utility.

2. The twenty five accessions showed significant differences for all the characters studied viz. plant height, plant spread, number of primary branches, leaf length, leaf width, pedicel length, days to1st flowering, days to 50 per cent flowering, pod setting per cent, pod length, pod girth, pod thickness, pod weight, number

of seeds pod^{-1}, number of pods plant^{-1}, yield plot^{-1}, 100 seed weight, shelling per cent, crude fibre and crude protein content.

3. Accession LP-26 (a pulse type) had maximum yield of 4.50 kg plot^{-1}. It produced 227.33 pods plant^{-1} with maximum pod setting per cent of 40.23 and minimum 100 seed weight of 17.57 g followed by accession LP-4 (a vegetable type) with an average yield of 3.33 kg plot^{-1} and 198.27 pods plant^{-1}. Earliness (27.77 days) and highest number of seeds pod^{-1} (6.40) was shown by the accession LP-16. The qualitative characters like crude protein and crude fibre content was found to be highest in accessions LP-1 and LP-21 respectively.

4. Highest gcv and pcv were observed for number of pods plant^{-1} followed by yield plot^{-1}.

5. High heritability and genetic gain were noted for all the characters viz. plant height, plant spread, number of primary branches, leaf length, leaf width, pedicel length, days to1st flowering, days to 50 per cent flowering, pod setting per cent, pod length, pod girth, pod thickness, pod weight, number of seeds pod^{-1}, number of pods plant^{-1}, yield plot^{-1}, 100 seed weight, shelling per cent, crude fibre and crude protein.

6. Correlation studies revealed strong association between yield and the traits pod setting per cent and number of pods plant^{-1}.

7. Results of path coefficient analysis brought out that number of pods plant^{-1} had the highest positive direct effect on yield followed by pod weight. Days to 50 per cent flowering imparted the highest negative effect on yield, followed by number of primary branches. Pod setting per cent had positive direct effect on yield.

8. The twenty five genotypes were grouped into five clusters based on genetic distance. There was no parallelism between geographical distribution and genetic diversity. Intra cluster distances were much lesser than inter cluster distances, suggesting homogeneity and heterogeneity of the strains within and between the clusters respectively. Therefore, it is possible to exploit heterosis in lablab bean. The entries in the single variety clusters being diversed from others may prove to be highly potential parents for breeding programme.

9. A selection model was formulated consisting of the characters, viz. plant height, plant spread, number of primary branches, leaf length, leaf width, pedicel length, days to 1st flowering, days to 50 per cent flowering, pod setting per cent, pod length, pod girth, pod thickness, pod weight, number of seeds pod^{-1}, number of pods plant^{-1}, yield plot^{-1}, 100 seed weight, shelling per cent, crude fibre and crude protein content with good efficiency over direct selection.

10. Comparison of different genotypes based on the index value revealed the superiority of genotypes LP-26 (for rabi season) followed by LP-4 (both summer and rabi season) and LP-2 (for rabi season).

11. The seasonal effect significantly influenced vegetative and reproductive characters during both the seasons viz., rabi and summer.

12. Due to the photosensitive nature the performance of the crop was better during rabi than summer in terms of productivity. It can be attributed to high temperature, water stress and long days during summer.

References

REFERENCES

Aher, S.R., Mate, S.N. and Tagad, T.N. 2006. Effect of morpho-physiological parameters on yield and yield contributing characters in germplasm of black gram (*Vigna mungo (L.) Repper). Legume Res.* 29(2): 154-156

Alertor, V.A. and Aladetimi, O. 1989. Compositional evaluation of some cowpea varieties and some under utilized edible legumes in Nigeria. *Nahrung.* **33**(10): 999-1007

Alkari, S., Vishwakarma, M. and Aurangabadkar, L.P. 2006. *Doilchos lablab* – An unexplored potential. In: *Abstracts, 1st International conference on Indigenous vegetables and legumes;* 12-15, Dec. Hyderabad. India. P. 69.

Allard, R.W. 1960. *Principles of Plant Breeding.* John Wiley and Sons Inc., New york, 98p.

Ampily, M. 2005. G x E interaction of semi-erect cowpea genotypes. M.Sc. (Hort.) thesis, Kerala Agricultural University, Trichur, 113p.

Apte, U.B., Chavan, S.A. and Yadav, B.B. 1991. Correlation studies in cowpea. *Agric. Sci. Digest.* **11**(2): 59-62

AOAC. 1980. *Official Methods of Analysis.* 13th edition. Association of official analytical chemists, Washington D.C., 1018 p.

Arunachalam, A.S. 1979. Genetic variability and correlation studies in field bean (*Dolichos lablab var lignosus). Mysore J. agric. Sci.* 8(3): 369.

Bagade, A.B., Patel, D.U. and Mali, S.C. 2002. Combining ability studies in Indian bean (*Dolichos lablab L.*). *Ann. Plant. Physiol.* 16(2): 187-190

Bagade, A.B., Patel, D.U., Mali, S.C. and Patel, P.B. 2004. Correlation and path analysis in a Diallele cross of Indian bean. *Ann. Agri. Res. New series.* **25**(1): 49-51

Basawana, K.S., Pandita, M.L., Dhanakar, B.S. and Pratap, P.S. 1980. Genetic variability and heritability studies on Indian bean *(Dolichos lablab var. lignosus L.). Haryana J. Hort. Sci.* **9**(1-2): 52-55

Basu, A., Samanta, S.K. and Sasmala, A.C. 2002. Genetic analysis for some seed parameters in lablab bean. *Veg. Sci.* **29**(1): 17-19

Bhuvaneshwari, A. and Muthiah, A.R. 2003. Inheritance of some characters in lablab bean. In: Kumar, D. and Singh, N.B. (eds.), *Advances in Arid Legume Research.* Scientific Publishers (India), pp 140-143.

Bhuvaneshwari, A. and Muthiah, A.R. 2005. Heterosis and inbreeding depression in lablab bean (*Lablab purpureus var. typicus*). *Legume Res.* **28**(2): 149-151

Biju, M.G. 2000. Genetic variability in hyacinth bean. *(Lablab purpureus. (L.).Sweet).* M.Sc. (Hort.) thesis, Kerala Agricultural University, Trichur, 65p.

Biju, M.G., Prasanna, K.P. and Rajan, S. 2001. Genetic divergence in hyacinth bean. *Veg. Sci.* **28**(2): 163-164

Birari, S.P. and Ghanekar, S.L. 1992. Genetic diversity in lablab bean. *J. Maharashtra Agric. Univ.* **17**(2): 257-260

Borah, P. and Shadeque, A. 1992. Studies on genetic variability of common dolichos bean. *Indian J. Hort.* **49**(3): 270-273

Burton, G.W. 1952. *Quantitative inheritance in grasses. Proceedings of sixth International grassland congress,* 15-16 May, 1951 (ed. Henry, A.), Manila, Philippines, pp 277-283.

Burton, G.W. and Devane, E.H. 1953. Estimating heritability in tall fescue from replicated clonal material. *Agron. J.* **45**: 478-481

Chaubey, P.K., Singh, S.P. and Chaubey, T. 2003. Genetic divergence in rajmash *(Phaseolus vulgaris L.). Veg. Sci.* **30**(2): 190-191

Cherian, E.V. 2000. Variability in *Capsicum chinense*. M.Sc. (Hort.) thesis, Kerala Agricultural University, Trichur, 79p.

Chetia, A., Borua, I. and Sarkar, C. R. 2000. Nutritional and antinutritional factors of a few improved varieties of field bean *(Dolichos lablab L.)* seeds. *Res. Crops*. **1**(1): 40-44

Chikkadevaiah., Shanta, R., Shivashankar, G. and Hiremath. 2005. Inheritance of four characters in *Dolichos lablab* L. *Cell. Mol. Life Sci.* **35**(2): 171-172

Dahiya, M.S., Pandita, M.L. and Vashistha, R.N. 1992. Correlation and path analysis studies in sem *(Dolichos lablab var. lignosus L.). Haryana J. Hort. Sci.* **11**(1-2): 72-75

Das, A.R., Hajra, P. and Som, M.G. 1987. Genetic variability and heritability studies in dolichos bean (*Dolichos lablab (Roxb.) L.). Veg. Sci.* **14**(2): 169-173

Das, N.D. 1987. Correlation and path analysis for quantitative characters and vegetable pod yield in dolichos bean. *Exp. Genet.* **3**(1-2): 51-55

Desai, N.C., Tikka, S.B.S. and Chauhan, R.M. 1996. Genetic variability and correlation studies in Indian bean (*Dolichos lablab var. lignosus). New. Botanist.* **23**(1-4): 197-204

Dewey, D.R. and Lu, K.H. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron. J.* **51**: 515-518

FAO. 1980. *Production yearbook.* Rome, Italy. **34**

Fisher, R.A. 1936. The use of multiple measurement in taxonomic problems. *Ann. Eugen.* 7: 179-188

Fisher, R.A. 1954. A fuller theory of junctions in breeding. *Heredity.* **8**: 187-197

Golani, I.J., Naliyadhara, M.V., Mehta, D.R., Purohit, V.L. and Pandya, H.M. 2006. Genetic divergence in Indian bean *(Lablab purpureus L.). Legume Res.* **29**(4): 286-288

Gopalan, A. and Balasubramanian, M. 1993. Component analysis for fodder yield in cowpea. *Madras agric. J.* **80**(4): 190-193

Gupta, S.K. and Samanta, S.K. 1991. Genetic variability for green pod yield and other characters in lablab bean. *Agric. Sci. Digest.* **11**(2): 95-99

Hazra, P., Das, P.K. and Som, M.G. 1993. Genetic divergence for pod yield and its components in cowpea. *Haryana J. Hort. Sci.* **22**(4): 296-302

IIHR. 1991. New vegetable varieties released by IIHR. *IIHR-News.* **12**(1): 1-4

Jadhav, V.T., Deshmukh, S.S. and Patil, S.S.D. 1996. Response of *Dolichos lablab L.* to irrigation and nitrogen. *J. Maharashtra Agric.Univ.* **21**(1): 155-156

Jalajakumari, M.B. 1981. Variability studies in cowpea. M.Sc. (Ag.) thesis, Kerala Agricultural University, Thrissur, 138p.

Jana, S., Som, M.G. and Das, M.D. 1982. Genetic variability and correlation studies in cowpea. *Veg. Sci.* **9**(2): 96-107

Jindal, S.K. and Gupta, B.S. 1984. Component analysis of yield in cowpea. *Indian J. agric. Sci.* **54**(3): 183-185

Johonson, H.W., Robinson, H.F. and Comstock, R.E. 1955. Estimates of genetic and environmental variability in soyabean. *Agron. J.* **47**: 314-318

Joshi, S.N. 1971. Studies on genetic variability for yield and its components in Indian bean *(Dolichos lablab) Madras. agric. J.* **53**: 367-371

Kale, R.B., Mahakal, K.G., Damke, M.M., Patil, V.S. and Jadhao, B.J. 1997. Response of Konkan Bhushan dolichos bean (*Dolichos lablab L.*) to nitrogen and phosphorus fertilization under Vidarbha conditions. *PKV-Res. J.* **21**(2): 135-138

Kandaswamy, G., Rajasekhara, S. and Manoharan, V. 1993. Path analysis in cowpea. *Madras. agric. J.* **80**(5): 293-294

Kannan, B., Paramasivan, K.S. and Paramasivum, K. 2003. Combining ability analysis for yield and its components in lablab bean *(Lablab purpureus (L.) Sweet). Legume Res.* **26**(3): 188-191

Kathi, V. 2002. Acceptabilty and nutritional evaluation of hyacinth bean genotypes. M.Sc (Home science). thesis, Kerala Agricultural University. Trichur, 72p.

KAU (Kerala Agricultural University). 2002. *Package of Practice Recommendations: Crops.* Directorate of Extension, Kerala Agricultural University, Thrissur, Kerala, 267p.

Kumari, R.U. and Chandrasekaran, P. 1991. Genetic divergence in fodder lablab. *Indian J. Genet. Pln. Breeding.* **51**(1): 28-29

Kumari, V., Arora, R.N. and Singh, J.V. 2003. Variability and path analysis in grain cowpea. In: Kumar, D. and Singh, N.B. (eds.), *Advances in arid legume research.* Scientific Publishers (India), pp 59-62.

Li, C.C. 1955. *Population Genetics.* The University of Chicago Press, London, 254p.

Lin, P.Y., Ming, W.X., Mi, L. and Wu, T.C. 2001. A new extremely early variety of *Dolichos lablab L.* 'Xiangbiandou 1'. *Acta Hort. Sinica.* **28**(5): 480

Linnaeus, 1763. *Species Plantarum* **2**: 1021

Lush, J.L. 1949. *Animal Breeding Plans.* Lown state University Press, Annes, 473p.

Mahalanobis, P.C. 1936. On the generalized distance in statistics. *Proc. Nat. Inst. Sci. India.* **2**: 39-55

Marangappanavar, L.R. 1986. Genetic diversity, gene action and character association in cowpea *(Vigna unguiculata L. Walp.). Mysore J. agric. Sci.* **20**: 231-233

Mathew, A. 1999. Genetic variability in bottle gourd in relation to yield and yield attributes. M.Sc. (Hort.) thesis, Kerala Agricultural University, Trichur, 64p.

Medikus, 1787. Vorles churpf. *Phys. Ges.* **2**: 354

Mishra, R.M., Koutu, G.K. and Bilaiya, B.K. 1987. D^2 and metnoglyph analysis in soya bean. *J. Oil Seeds Res.* 4(1): 103-107

Mohan, N. and Aghora, T.S. 2006. Collection and Evaluation of dolichos bean (*Lablab purpureus* [L.] Sweet) Germplasm in Tamil Nadu. In: *Abstracts, 1st International conference on Indigenous vegetables and legumes;* 12-15, Dec. Hyderabad. India. P. 4.

Mozumdar, S.N., Moniruzamman, M., Rahaman, S.M.M., Sarkar, P.C. and Basak, N.C. 2007. Influence of support systems and spacing on hyacinth bean production in the eastern hilly area of Bangladesh. *Legume Res.* **30**(1): 1-9

Murphy, A.M. and Colucci, P.E. 1999. A tropical forage solution to poor quality ruminant diets: A review of *Lablab purpureus*. *Livestock Research for Rural Development.* **11**(2): 25-29

Murthy, P. and Kumar, B.M.D. 2004. Studies on seed development and physiological maturity in field bean *(Lablab perpureus (L.) Sweet). Legume Res.* **27**(2): 134-136

Nandi, A., Tripathy, P. and Lenka, D. 1997. Correlation, Co-heretability and path analysis studies in dolichos bean. *ACIAR Fd. Legume Newsl.* **25**: 1-2

Nandi, A., Tripathy, P. and Lenka, D. 1998. Divergence analysis in dolichos bean *(Lablab purpureus (L.) Sweet). ACIAR Fd. Legume Newsl.* **28**: 9-10

Nandi, A., Tripathy, P. and Lenka, D. 2000. Genetic divergence in hyacinth bean *(Dolichos lablab). Indian. J. Agric. Sci.* 70(7): 450-451

Narayanankutty, C., Mili, R. and Jaikumaran, U. 2003. Combining ability analysis in vegetable cowpea *(Vigna unguiculata L.). Indian J. Hort.* 60(3): 257-261

Nath, S. and Korla, B.N. 2004. Path analysis of some quantitative characters in dwarf french bean *(Phaseolus vulgaris L.)* in relation to pod yield. *Legume Res.* 27(3): 228-230

Nayar, K.M.D. 1982. Studies on genetic divergence and breeding behaviour of few intervarietal crosses in field bean *(Lablab purpureus L. Sweet). Mysore J. agric. Sci.* 16(4): 486

Newaz, M.A.1990. *Proc. BAU Res. Prog.* **4**: 66-79

Oseni, T.O., Lenge, D.D. and Tal, U.R. 1992. Correlation and path coefficient analysis of yield attributes in diverse lines of cowpea. *Indian J. agric. Sci.* **62** (6): 352-368

Pandey, R.P. and Dubey, K.C. 1972. Studies on variability in *Dolichos lablab. JNKVV-Res. J.* 6(2): 145-148

Pandita, M.L., Panday, S.C., Sidhu, A.S. and Arora, S.K. 1980. Studies on genetic variability and correlation in Indian bean *(Dolichos lablab). Haryana J. Hort. Sci.* 9(3-4): 154-159

Patil, S.J., Venugopal, R., Goud, J.V. and Parameswarappa, R. 1989. Correlation and path analysis in cowpea. *Karnataka J. agric. Sci.* **2**: 170-175

Peter, K.V. 1998. *Genetics and Breeding of Vegetables.* Directorate of Information and Publications of Agriculture. ICAR, New Delhi, 333p.

Philip, A. 1984. Genetic variability and correlation studies in winged bean *(Psophocarpus tetragonolobus).* M.Sc. (Hort.) thesis, Kerala Agricultural University, Vellanikkara, Thrissur, 87p.

Prashanthi, L. 2005. Inheritance of photosensitivity in lablabbean *(Lablab purpureus (L.) Sweet). Legume Res.* **28**(3): 233-234

Rai, N. and Yadav, D. S. 2005. *Advances in Vegetable Production.* Researchco Book Centre, New Delhi, 996p.

Rai, N., Yadav, D.S. and Asati, B.S. 2003. Genetic divergence and path analysis for yield and its traits in Indian bean *(Lablab purpureus (L.) Sweet). Veg. Sci.* **30**(2): 115-119

Rai, N., Yadav, D.S., Asati, B.S. and Singh, A.K. 2004 Genetic analysis in french bean *(Phaseolus vulgaris L.) Veg. Sci.* **31**(2): 138-141

Rajput, J.C., Palve, S.B., Kanade, V.M. and Wagh, R.G. 1994. 'Konkan Bhushan': a dwarf hyacinth bean. *Indian Hort.* **38** (4): 7

Ramasamy, P., Balasubramanian, M., Gnanam, R. and Rangasamy, P. 1990. CO 11 avarai *(Lablab purpureus var. typicus (L.) Sweet)* a new short duration photo insensitive variety for Tamil Nadu. *Madras agric. J.* 77(3-4): 121-124

Rao, M.G.R. 1981. Genetic analysis of quantitative characters in field bean *[Lablab purpureus (L.) Sweet]. Univ.Agric. Sci.,* Thesis Abstracts. **12**(3): 78-79

Rathnaiah, T.R. 1982. The study of variability and formulation of selection indices for vegetable yield in field bean *[Lablab purpureus (L.) Sweet].* M.Sc. (Hort.) thesis, University of Agricultural Sciences, Bangalore, 111p.

Rathnaiah, T.R. 1985. The study of variability and formulation of selection indices for vegetable yield in field bean *[Lablab purpureus (L.) Sweet]. Univ. Agric. Sci.* Thesis Abstracts. **19**(3): 216

Reddy, M. 1982. Genetic variability studies and formulation of selection indices in field bean *[Lablab purpureus (L.) Sweet]. Univ. Agric. Sci.* Thesis Abstracts. **8**(1): 69-70

Reddy, S.A., Geetha, S., Reddy, K.M., Sharma, P.S. and Reddy, G.S. 1991. Growth and yield as affected by different plant densities in bush type dolichos bean (*Dolichos lablab L var. typicus*). *J. Res. APAU.* **19** (2): 66-69

Robinson, H.F., Comstock, R.E. and Harvey, P.H. 1949. Estimates of heritability and the degree of dominance in corn. *Agron J.* **41**: 353-359

Roxburgh, W. 1832. *Flora Indica.* Thackery and Co, Calcutta, 521p.

Sadasivum, S. and Manickam, A. 1992. *Biochemical methods for Agriculture Sciences*. Wiley Easter Ltd., New Delhi, 129p.

Sathyanarayana, A. and Gangadharappa, K. 1982. Correlations and path analysis in segregating populations of garden bean *(Dolichos lablab var. typicus). The Andhra Agric. J.* **29**: 190-193

Saud, B.K. and Bhorali, P. 1998. Evaluation of dolichos bean cultivars of southern Assam. *J. agric. Sci. Soc. N-E India.* **11** (2): 183-188

Savi, 1824. *NUOV. Giorn. Left.* (Pisa) **8: 116**

Sharma, P.C. and Luthra, S.K. 1987. Genetic divergence in lentil *(Lens culinary med.). Genetica Agraria.* **41**(4): 349-359

Shivashankar, G., Kulkarni, R.S., Shashidhar, H.E. and Mahishi, D.M. 1993. Improvement of field bean. In: Chadha, K.L. and Kalloo, G. (eds.), *Advances in Horticulture.* Malhotra Publishing House, New Delhi, pp 277-286.

Sickhar, V.I., Grigonyan, E.M. and Lugovoi, A.P. 1988. Multivariate analysis of Mahalanobis distance parameters for economically usefull characters in different groups of soyabean. *Tsitologiva-i-Genetica.* **22**(3): 37-45

Singh, A.K. 1993. Genetic variability and correlation studies in French bean. *Haryana J. Hort. Sci.* **22**(3): 235-239

Singh, A.K., Gautam, N.C. and Singh, H. 1985. Genetic variability and correlation studies in sem *(Lablab purpureus L. Sweet). Indian J. Hort.* **42**(3-4): 252-257

Singh, B., Parthasarathy, V.A. and Medhi, R.P. 1992. Response of bush-type field bean (*Dolichos lablab var lignosus*) varieties to phosphorus. *Indian J. agric. Sci.* **62** (10): 692-694

Singh, D., Dhillon, N.P.S. and Singh, G.J. 2004. Evaluation of semphali *(Dolichos lablab L.)* germplasm under rainfed conditions. *Haryana. J. Hort. Sci.* **33** (3-4): 267-268

Singh, J.D. and Singh, I.P. 2006. Genetic variability, heritability, expected genetic advance and character association in field pea *(Pisum sativum L.). Legume Res.* **29**(1): 65-67

Singh, N.C., Gautam, N.C. and Singh, K. 1982. Genetic variability and correlation studies in sem *(Lablab purpureus L. Sweet). Indian J. Hort.* **30**: 252-257

Singh, N.P. 2005. *Basic Concepts of Vegetable Science.* International Book Distributing CO, Lucknow, 463p.

Singh, S.P. and Gupta, K.K. 1980. Genetics of leaf size in lablab beans. *Progr. Hort.***12**(1):71-75

Singh, S.P. 1991. Genetic divergence and canonical analysis in hyacinth bean *(Dolichos lablab). J. Genet. Pnt. Breed.* **45**(1): 7-11

Singh, S.P., Singh, H.N., Singh, N.P. and Srivastava, J.P. 1979. Genetic studies on yield components in lablab bean. *Indian J. Agric. Sci.* **49**(8): 579-582

Singh, S.P., Singh, H.N., Singh, N.P. and Srivastava, J.P. 1986. Genetic studies of flowers and pods/raceme in hyacinth bean *(Dolichos lablab). Farm Sci. J.* (1-2): 85-88

Smith, H.F. 1936. A descriminant function for plant selections. *Ann. Eugen.* 7: 240-250

Sobha, P.P. 1994. Variability and heterosis in bush type vegetable cowpea. *(Vigna unguiculata(L.) Walp.).* M.Sc.(Hort.) thesis. Kerala Agricultural University,Trichur, 120p.

Srihara, P. 1976. The nutritive composition of 'Hebbal avare' is comparable to local varieties. *Curr. Res.* 5(6): 95-96

Sudhakumari, J.S. and Gopimony, R. 1994. Genetic divergence in cowpea. *Proceedings of the Sixth Kerala Science Congress;* 17-21 Jan. Kerala state committee on science, technology and environment, Government of Kerala, Thiruvanantapuram, pp 194-196.

Suresh, K.M. and Unnithan, V.K.G. 1996. A computer oriented iterative algorithm for clustering. *Indian J. Genet.* **56**: 412-124

Sweet, 1827. *Hort. Brit. ed.* **1**: 481

Thamburaj, S. and Singh, N. 2003. *Vegetables, Tubers and Spices.* ICAR, New Delhi, 469p.

Thiagarajan, K., Rathinswamy, R. and Rajashekharan, S. 1988. Genetic divergence in cowpea. *Madras agric. J.* **76**(12): 719-720

Tikka, S.B.S., Chauhan, R.M., Parmar, L.D. and Solanki, S.D. 2003. Character interrelationship in grain type Indian bean. In: Kumar, D. and Singh, N.B. (eds.), *Advances in arid legume research.* Scientific Publishers (India), pp 136-139.

Tyagi, P.C. and Koranne, R.D. 1988. Correlation and path analysis in cowpea *(Vigna unguiculata sub sp. cylindrica). Indian J. agric. Sci.* **58**(1): 57

Uddin, M.S. and Newaz, M.A. 1997. Genetic parameters and their association among flower and pod characterstics of hyacinth bean *(Lablab purpureus L.). Legume Res.* **20**(2): 82-86

Ushakumari, R. and Chandrasekharan, P. 1992. Genetic analysis in fodder lablab *(Lablab purpureus L.). Indian J. Genet. Pln. Breeding.* **52**(2): 169-173

Vaid, I.K. and Singh, K.B. 1983. Genetic variability in F_3 and F_4 populations of a cross in cowpea. *Madras agric. J.* **70**(5): 281-283

Vasanthi, S. And Das, L.D.V. 1995. Heterosis in fodder lablab *(Lablab purpureus). Madras. agric. J.* **82**(2): 148-150

Vashi, R.D., Prajapati, R.M. and Vashi, P.S. 1999(a). Genotype x environment interaction and stability analysis in Indian bean *(Dolichos lablab L.). Gujarat agric. Univ. Res. J.* **25** (1): 21-25

Vashi, R.D., Prajapati, R.M. and Vashi, P.S. 1999(b). Heterosis in Indian bean *(Dolichos lablab L.). Gujarat agric. Univ. Res. J.* **24** (2): 36-38

Vashi, R.D., Prajapati, R.M. and Vashi, P.S. 2001. Genetic analysis of yield and yield components over environments in Indian bean *(Dolichos lablab L.). Gujarat agric. Univ. Res. J.* **26**(2): 23-28

Veerabadhiran, P., Muthiah, A.R., Subbalakshmi, B., Nadarajan, N. and Raveendaran, T.S. 2006. Ultra short duration vegetable hyacinth bean (*Lablab purpureus var. typicus*) – A wonder. In: *Abstracts, 1st International conference on Indigenous vegetables and legumes;* 12-15, Dec. Hyderabad. India. P.34.

Veeramani, N.M., Venkatesan, P., Thangavel, P. and Ganesan, J. 2005. Path analysis for yield and its components in F2 populations of black gram *(Vigna mungo (L.) Hepper.). Legume Res.* **28**(1): 62-64

Wahab, A.M., Joseph, S., Mathew, S.K., Devadas, V.S. and Peter, K.V. 1991. Evaluation of selected varieties of vegetable cowpea *(Vigna unguiculata (L.) Walp.). Veg. Sci.* **18**(2): 222-224

Wright, S. 1921. Correlation and Causation. *J. agric. Res.* **20**: 557-585

Appendices

Appendix- I.

Weather data of Vellanikkara (2006 September to 2007 May)

Element	Year 2006				Year 2007				
	September	October	November	December	January	February	March	April	May
Relative humidity (%)	84	79	72	57	54	55	63	69	76
Rain fall (mm)	522.2	323.7	79	0	0	0	0	61	240.5
Rainy days	17	11	5	0	0	0	0	4	10
Sunshine hours	3.9	4.8	6.5	7.8	8.7	9.8	8.2	7.7	6.6
Maximum temperature(^{0}C)	29.6	31.0	31.7	31.5	32.5	34.0	36.0	35.7	32.8
Minimum temperature(^{0}C)	23.0	23.0	23.7	23.6	22.0	22.2	24.4	25.0	24.6

Abstract

PERFORMANCE ANALYSIS OF BUSH LABLAB BEAN (*Lablab purpureus* (L.) SWEET)

By

SREEKANTH K. S.

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the
requirement for the degree of

Master of Science in Horticulture

Faculty of Agriculture
Kerala Agricultural University

Department of Olericulture

COLLEGE OF HORTICULTURE
VELLANIKKARA, THRISSUR - 680 656
KERALA, INDIA

2007

ABSTRACT

An experiment was carried out at the College of Horticulture, Kerala Agricultural University, Vellanikkara during September 2006 – May 2007 to analyze the performance of bush lablab bean (*Lablab purpureus* (L.) Sweet). The major objectives of the study were to genetically catalogue the available germplasm and to study the genetic variability, divergence, heritability, genetic gain and correlation of different traits with yield. Twenty five accessions collected from different parts of the country were grown in randomized block design with three replications.

The 25 accessions were catalogued based on the descriptor for lablab bean. Significant differences for all the characters viz. plant height, plant spread, number of primary branches, leaf length, leaf width, pedicel length, days to 1st flowering, days to 50 per cent flowering, pod setting per cent, pod length, pod girth, pod thickness, pod weight, number of seeds pod^{-1}, number of pods plant^{-1}, yield plot^{-1}, 100 seed weight, shelling per cent, crude fibre and crude protein content were noticed among the accessions.

The accession LP-26 was found to be the highest yielder (4.5 kg plot^{-1}) coupled with high pod setting per cent (40.23) and number of pods plant^{-1} (227.33) during rabi. The accession LP-4 was found to be the best yielder during summer (1.15 kg plot^{-1}) and the second best yielder (3.33 kg plot^{-1}) coupled with second best pod setting per cent (38.00) and number of pods plant^{-1} (198.27) during rabi. Highest pod length (9.98 cm), pod girth (5.47 cm) and pod weight (4.61 g) was observed in the accession LP-27. Better shelling per cent (86.57) was expressed by the accession LP-7. Earliness (27.77 days) and highest number of seeds pod^{-1} (6.40) was shown by the accession LP-16. The qualitative characters like crude

protein and crude fibre content was found to be highest in accessions LP-1 and LP-21 respectively.

Highest genotypic coefficient of variation and phenotypic coefficient of variation was observed for number of pods plant^{-1}. High heritability coupled with genetic gain was noted for all the morphological, reproductive and qualitative characters. The 25 accessions were grouped into five clusters and no parallelism between geographical distribution and genetic diversity was observed.

A selection model was also formulated using these characters. Based on this the accession LP-26 (a pulse type) was identified as the best performer for rabi season and LP-4 (a vegetable type) for summer. The accession LP-4 is the second best one for rabi season.