GENETIC VARIABILITY AND HERITABILITY FOR GROWTH, YIELD AND SELECTED QUALITATIVE TRAITS IN CUCUMBER (*Cucumis sativus* L.) GENOTYPES

PUSHPALATHA N.

UHS13PGM410

DEPARTMENT OF VEGETABLE SCIENCE

COLLEGE OF HORTICULTURE, GKVK POST, BENGALURU-560 065

UNIVERSITY OF HORTICULTURAL SCIENCES

BAGALKOT-587 104

2015

GENETIC VARIABILITY AND HERITABILITY FOR GROWTH, YIELD AND SELECTED QUALITATIVE TRAITS IN CUCUMBER (*Cucumis sativus* L.) GENOTYPES

Thesis submitted to the

University of Horticultural Sciences, Bagalkot

in partial fulfillment of the requirements

for the award of the Degree of

Master of Science (Horticulture)

in

Vegetable Science

By

PUSHPALATHA N.

UHS13PGM410

DEPARTMENT OF VEGETABLE SCIENCE

COLLEGE OF HORTICULTURE, GKVK POST, BENGALURU-560 065

UNIVERSITY OF HORTICULTURAL SCIENCES

BAGALKOT-587 104

JUNE, 2015


DEDICATED TO
MY MOTHER

DEPARTMENT OF VEGETABLE SCIENCE
COLLEGE OF HORTICULTURE, BENGALURU
UNIVERSITY OF HORTICULTURAL SCIENCES, BAGALKOT

CERTIFICATE

This is to certify that the thesis entitled **"GENETIC VARIABILITY AND HERITABILITY FOR GROWTH, YIELD AND SELECTED QUALITATIVE TRAITS IN CUCUMBER (*Cucumis sativus* L.) GENOTYPES"** submitted by **Ms. PUSHPALATHA, N., ID No. UHS13PGM410,** in partial fulfillment of the requirements for the award of the degree of **MASTER OF SCIENCE (Horticulture)** in **VEGETABLE SCIENCE** to the University of Horticultural Sciences, Bagalkot, is a *bonafide* record of research work carried out by her during the period of her study in this University, under my guidance and supervision and no part of the thesis has been previously submitted for the award of any degree, diploma, associateship, fellowship or any other similar titles.

BENGALURU
JUNE, 2015

ANJANAPPA, M.
(Major Advisor)

APPROVED BY:

Chairperson: ____________________
(ANJANAPPA M.)

Members : 1. ____________________
(DEVAPPA V.)

2. ____________________
(PITCHAIMUTHU M.)

3. ____________________
(SURENDRA H. S.)

ACKNOWLEDGEMENT

The beatitude and euphoria that accompanies successful completion of any task would be incomplete without expression of appreciation of simple certitude to the people who made it possible to achieve the goal by their encouraging guidance and proper steering. It is still great at this juncture to recall all the faces and spirit in the form of teachers, friends, near and dear ones.

I feel extremely honoured for the opportunity bestowed by Almighty upon me to work under the versatile guidance of ***Dr. Anjanappa, M.*** *Professor, Dept. of Vegetable Science, College of Horticulture, Bengaluru and Chairman of Advisory Committee, for his excellent guidance and encouragement in completion of this thesis. It is my privilege to record a deep sense of gratitude for the valuable guidance, constant inspiration, kind help constructive criticism, unfailing interest and meticulous planning right from suggesting the problem till the completion of this thesis.*

I am very much grateful to my advisory committee members, ***Dr. V. Devappa,*** *Professor and Head, Dept. of Plant Pathology, College of Horticulture Bengaluru,* ***Dr. Pitchaimuthu, M.,*** *Principal Scientist Division of Vegetable Crops, IIHR, Hesaraghatta, Bengaluru,* ***Mr. H. S. Surendra,*** *Associate Professor, Dept. of Statistics, UAS, GKVK, Bengaluru for their constant supervision, valuable guidance and all the facilities extended during the course of this investigation.*

I express my sincere thanks to ***Dr. H. B. Lingaiah,*** *Dean and Campus Head College of Horticulture, Bengaluru,* ***Dr. Jaganath, S.,*** *Professor and Head of the Fruit Science Department,College of Horticulture, Bengaluru, for their valuable administrative support during course of investigation. I am extremely grateful to* ***Dr. B. Fakrudin****, Professor and Head, Dept. of Crop Improvement and Biotechnology, College of Horticulture, Bengaluru,* ***Dr. Ratnakar Shet****, Assistant Professor, Dept. of Vegetable Science, College of Horticulture, Sirsi,* ***Dr. Venkatesh****, Associate Professor, Mandya for their support in collection of materials and* ***Mrs. Jyothi Kattegoudar****, Assistant Professor, Dept. of Vegetable Science, College of Horticulture, Bengaluru for her supervision and valuable guidance.*

It is my pleasure to thank my friends and seniors ***Ambarish, C.B., Ibaad, Nagesh sir, Suresh sir, Praveen sir, Anand sir, Mamatha, Sushmitha, Manjesh, Nayana, Kumar, Manoj, Vijayalakshmi, Ratandas*** *and many more friends for their help and advice during my degree programme.*

One uses the choicest words to acknowledge the invaluable help rendered by someone very close to heart. But, I find such a measure inadequate to quantify the sacrifices, love, affection, support and concern shown to me by my father ***Late Sri C. Nagaraju****, mother* ***Smt. Lakshmidevi****, sister* ***Shilpa, N*** *and Brother* ***Karthik, N.*** *Their unselfish struggle towards my wellbeing and attainment of perfection in carrier goals has been boundless and my gratitude is beyond words.*

Above all I am extremely thankful and grateful to ***Almighty God*** *who has blessed me to be what I am today.*

End is inevitable for any kind of work. Though acknowledging is an endless task, I end by saying infinite thanks to all those whom I am able to recall here and also to those whom I might have left unknowingly.

Bengaluru

June,2015 ***(Pushpalatha, N.)***

GENETIC VARIABILITY AND HERITABILITY FOR GROWTH, YIELD AND SELECTED QUALITATIVE TRAITS IN CUCUMBER (*Cucumis sativus* L.) GENOTYPES

Abstract

An investigation was carried out at College of Horticulture, Bengaluru during 2014-15 to assess the genetic variability of cucumber genotypes for growth, yield and qualitative traits. The experiment was laid out in a Randomized Block Design (RBD) with two replications. Estimation of PDI for downy mildew incidence was carried out to record the disease reaction.

The analysis of variance revealed wide range of variability existed in different cucumber genotypes for all the traits studied. The phenotypic and genotypic coefficients were higher for vine length, number of branches, number of nodes, fruit length, flesh thickness, fruit cavity, average fruit weight, fruits per plant, yield per plant and number of seeds per fruit. The high heritability coupled with high genetic advance as per cent mean were observed for all the traits except for days to first female flower anthesis, days to 50 per cent flowering, days to first fruit harvest and fruit moisture. Correlation and path analysis studies revealed the significant positive and high direct effects of number of fruits per plant, average fruit weight, fruit moisture per cent, number of seeds per fruit and fruit cavity on fruit yield of cucumber.

The genotypes TMG-1 followed by EUM-402-102 and Salad Cucumber showed good performance with respect to fruit yield, fruit length and average fruit weight. The genotype Dharwad Local was noticed as resistant and CH-20 as susceptible to downy mildew disease. Four genotypes Sambar Sauthe, White Long, IIHR-304 and Poinsette were found moderately resistant and remaining eighteen genotypes were of moderately susceptible.

Pushpalatha, N.	Anjanappa, M.
(Student)	(Chairperson)

ಸೌತೆಕಾಯಿ (*ಕುಕುಮಿಸ್ ಸಟೈವಸ್*) ವಂಶವಾಹಿಗಳಲ್ಲಿ ಬೆಳವಣಿಗೆ, ಇಳುವರಿ ಮತ್ತು ಗುಣಾತ್ಮಕ ಲಕ್ಷಣಗಳ ಅನುವಂಶಿಕ ವೈವಿಧ್ಯತೆ ಮತ್ತು ಅನುವಂಶೀಯತೆಯ ಅಧ್ಯಯನ

ಪುಷ್ಪಲತಾ, ಎನ್.

ಸಾರಾಂಶ

ತೋಟಗಾರಿಕಾ ವಿಜ್ಞಾನಗಳ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಬಾಗಲಕೋಟೆ ವ್ಯಾಪ್ತಿಯ ತೋಟಗಾರಿಕಾ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಂಗಳೂರಿನಲ್ಲಿ ೨೦೧೪–೧೫ ರ ಹಿಂಗಾರಿನಲ್ಲಿ ಸೌತೆಕಾಯಿ (*ಕುಕುಮಿಸ್ ಸಟೈವಸ್*) ವಂಶವಾಹಿಗಳಲ್ಲಿ ಬೆಳವಣಿಗೆ, ಇಳುವರಿ ಮತ್ತು ಗುಣಾತ್ಮಕ ಲಕ್ಷಣಗಳ ಅನುವಂಶಿಕ ವೈವಿಧ್ಯತೆ ಮತ್ತು ಅನುವಂಶೀಯತೆಯ ಅಧ್ಯಯನ ಎಂಬ ಕ್ಷೇತ್ರ ಸಂಶೋಧನೆಯನ್ನು ನಡೆಸಲಾಯಿತು. ಈ ಪ್ರಯೋಗದಲ್ಲಿ ವೈವಿಧ್ಯಮಯ ಸೌತೆಯ ವಂಶವಾಹಿಗಳನ್ನು ಎರಡು ಪುನರಾವೃತ್ತಿಗಳಲ್ಲಿ ಬೆಳೆಸಿ ಆರ್.ಬಿ.ಡಿ. ಮಾದರಿಯಲ್ಲಿ ಸಂಶೋಧನೆಯನ್ನು ಕೈಗೊಳ್ಳಲಾಯಿತು.

ಸಸ್ಯದ ಗುಣಲಕ್ಷಣಗಳಾದ ಗಿಡದ ಉದ್ದ, ಕವಲುಗಳ ಸಂಖ್ಯೆ, ಗೆಣ್ಣುಗಳ ಸಂಖ್ಯೆ, ಕಾಯಿಯ ಉದ್ದ, ತಿರುಳಿನ ದಪ್ಪ, ಕಾಯಿಯ ಕುಹರದ ಅಳತೆ, ಸರಾಸರಿ ಹಣ್ಣಿನ ತೂಕ, ಪ್ರತಿ ಗಿಡದಲ್ಲಿನ ಕಾಯಿಗಳ ಸಂಖ್ಯೆ, ಪ್ರತಿ ಗಿಡದ ಇಳುವರಿ ಮತ್ತು ಪ್ರತಿ ಕಾಯಿಯಲ್ಲಿನ ಬೀಜಗಳ ಸಂಖ್ಯೆಯಲ್ಲಿ ಹೆಚ್ಚಿನ ವಂಶವಾಹಿರೂಪ ಗುಣಾಂಶ ವಿಭಿನ್ನತೆ ಮತ್ತು ದೃಶ್ಯವಾಹಿರೂಪ ಗುಣಾಂಶ ವಿಭಿನ್ನತೆ ಕಂಡು ಬಂದಿತು. ಗಿಡದ ಗುಣಲಕ್ಷಣಗಳಾದ ಮೊದಲ ಹೆಣ್ಣು ಹೂವಿನ ಅರಳುವಿಕೆಗೆ ತೆಗೆದುಕೊಂಡ ದಿನಗಳು, ಶೇಕಡ ೫೦ ರಷ್ಟು ಹೂ ಬಿಡುವ ದಿನಗಳು, ಮೊದಲ ಕಾಯಿಯ ಕೊಯ್ಲು ಮತ್ತು ಕಾಯಿಯ ತೇವಾಂಶಗಳನ್ನು ಹೊರತು ಪಡಿಸಿ ಉಳಿದೆಲ್ಲಾ ಗುಣಲಕ್ಷಣಗಳಲ್ಲಿ ಹೆಚ್ಚಿನ ಅನುವಂಶೀಯತೆ ಮತ್ತು ಅನುವಂಶೀಯ ಸುಧಾರಣೆಯು ಕಂಡು ಬಂದಿದೆ. ಸೌತೆಯ ಇಳುವರಿಯು ಗಿಡದ ಲಕ್ಷಣಗಳಾದ ಪ್ರತಿ ಗಿಡದಲ್ಲಿನ ಕಾಯಿಗಳ ಸಂಖ್ಯೆ, ಸರಾಸರಿ ಕಾಯಿಯ ತೂಕ, ಕಾಯಿಯ ತೇವಾಂಶ, ಪ್ರತಿ ಕಾಯಿಯಲ್ಲಿನ ಬೀಜಗಳ ಸಂಖ್ಯೆ ಮತ್ತು ಕಾಯಿಯ ಕುಹರಗಳೊಂದಿಗೆ ಧನಾತ್ಮಕ ಸಹಸಂಬಂಧ ಮತ್ತು ನೇರ ಧನಾತ್ಮಕ ಸಂಬಂಧವನ್ನು ಹೊಂದಿರುತ್ತದೆಯೆಂದು ತಿಳಿದುಬಂದಿದೆ.

ಸೌತೆಯ ವಂಶವಾಹಿಗಳಾದ ಟಿ.ಎಂ.ಜಿ-೧, ಇ.ಯು.ಎಮ್-೪೦೨-೧೦೨ ಮತ್ತು ಸಲಾಡ್ ಕುಕುಂಬರ್ ವಂಶವಾಹಿಗಳು ಬೇರೆ ವಂಶವಾಹಿಗಳಿಗಿಂತ ಉತ್ತಮವಾದ ಇಳುವರಿ ಮತ್ತು ಸರಾಸರಿ ಕಾಯಿಯ ತೂಕವನ್ನು ಹೊಂದಿವೆ. ವಂಶವಾಹಿ ಧಾರವಾಡ ಲೋಕಲ್ ಬೂಜು ತುಪ್ಪಟ ರೋಗ ನಿರೋಧಕ ಮತ್ತು ಸಿ.ಎಚ್-೨೦ ವಂಶವಾಹಿಯು ಹೆಚ್ಚು ರೋಗಕ್ಕೆ ತುತ್ತಾಗುವ ವಂಶವಾಹಿಯಾಗಿದ್ದು, ಸಾಂಬಾರ್ ಸೌತೆ, ವೈಟ್ ಲಾಂಗ್, ಐ.ಐ.ಎಚ್.ಆರ್-೩೦೪ ಹಾಗೂ ಪೊಯಿನ್ಸೆಟ್ಟೆ ವಂಶವಾಹಿಗಳು ಮಧ್ಯಮ ಪ್ರಮಾಣದ ರೋಗ ನಿರೋಧಕಗಲಾಗಿದ್ದು, ಉಳಿದ ಹದಿನೆಂಟು ವಂಶವಾಹಿಗಳು ಮಧ್ಯಮ ಪ್ರಮಾಣದ ರೋಗಕ್ಕೆ ತುತ್ತಾಗುವ ವಂಶವಾಹಿಗಳು ಎಂಬುದು ಈ ಅಧ್ಯಯನದಿಂದ ತಿಳಿದು ಬಂದಿದೆ.

ದಿನಾಂಕ: ಜೂನ್, ೨೦೧೫
ಸ್ಥಳ: ತೋಟಗಾರಿಕಾ ಮಹಾವಿದ್ಯಾಲಯ,
ಯು.ಎಚ್.ಎಸ್. ಆವರಣ, ಜಿ.ಕೆ.ವಿ.ಕೆ, ಬೆಂಗಳೂರು-೬೫

ಅಂಜನಪ್ಪ, ಎಮ್.
(ಮುಖ್ಯ ಸಲಹೆಗಾರರು)

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

I. INTRODUCTION

Cucumber (*Cucumis sativus* L.) is one of the most popular vegetable of cucurbitaceae family, with the chromosome number 2n=14. As a vegetable crop, cucumber has great economic importance. In India 6,40,990 tonnes of cucumbers are produced from an area of 40,900 hactares with an average productivity of 15.63 M. Tonnes per hectare (Anon., 2014). In Karnataka the area under cucumber cultivation is about 6,903 hactares with an annual production of 1,03,396 M. Tonnes. The average productivity of cucumber in Karnataka is about 14.98 M. Tonnes per hectare (Anon., 2013a).

Cucumber has originated in India. The genus *Cucumis* comprises of 30 species which are distributed in Africa and Asia. The species of Africa are found in different parts of Africa, Middle East, Sudan, Egypt, Ethiopia and Pakistan. The Asiatic species are distributed in India, China, Myanmar and Korea. The African species include annuals and perennials; monocious and diocious species. The wild species, *Cucumis sativus* L. *var. hardwickii* Alex. found along the foot hills of the Himalayas is a feral form of the cultivated cucumber. The species *Cucumber sativus* L*.* has a wide range of variability. It has become the fourth important vegetable in the world, after tomato, cabbage and onion (Tatilioglee, 1993).

Cucumber is grown as an ideal summer vegetable crop worldwide for its edible tender fruits. It is a versatile fruit consumed in various ways, as salad ingredient, pickle, desert fruit, as a cooked vegetable and it has got cooling effect also. It is ideal for people suffering from jaundice and allied diseases and also very much useful in preventing constipation. Due to high content of potassium (50-80 mg/100 g), cucumber can be highly useful for both high and low blood pressures (Kashif *et al*., 2008). Seeds contain oil, which is helpful for brain development and body smoothness. Hence, it is being used in Ayurvedic preparations (Robinson and Decker-Walter, 1999). In addition, cucumber is cultivated because its extract has soothing, cleansing and softening properties which are important for the cosmetics industry. Due to their low energy content they are mainly regarded as refreshing condiment. In 100 g edible portion, the cucumber contains 96 g water, 0.6 g protein, 0.1 g fat, 2.2 g carbohydrate, 45 IU vitamin A, 0.03 mg vitamin B_1, 0.02 mg vitamin B_2, 0.3 mg niacin, 12 mg vitamin C, 12 mg calcium, 0.3 mg iron, 15 mg magnesium and 24 mg phosphorus (Esquinas and Gulick, 1983).

Cucumber is a warm season crop but, requires slightly milder climate than melons for better growth and development. However, it can be grown in both summer and rainy seasons, but it cannot tolerate frost and cold temperature. Due to monoecious nature and insect pollination higher genetic diversity exists within a population. India being centre of origin of cucumber, numerous diversified forms varying in fruit length, diameter and flesh quality are available. Depending upon local market preferences in cucumber, several land races or local cultivars have established themselves in different geographical regions of India. These cultivars exhibit enormous variability with respect to fruit traits but are basically poor yielder.

In spite of its importance, large variability, adaptability and uses, the research priority given to this crop especially in crop improvement aspect is highly meagre in our country. There is a paramount need to assess the genetic variability and its exploitation can bring out a speedy crop improvement. It was therefore, considered worthwhile to collect such materials from various places and local markets for breeding towards an effective improvement in fruit traits and yield. Selection of elite genotypes depends upon the total variability and transmissibility of characters from parents to their offspring. Thus, the knowledge of genetic and environmental forces is essential for effective breeding programme. It also reflect the comparative value of heredity and environment on the character(s) for which the selection is practiced, the heritability likely measuring utility when expressed in terms of genetic advance. However the expected responses to selection are proportional to heritability (Falconer, 1960).

Downy mildew is one of the serious foliar diseases in cultivation of cucurbits due to its wider distribution throughout the world (Palti and Cohen, 1980). Downy mildew on cucurbits can be found in diverse geographic areas ranging from semi-arid to tropical climates. Cucumbers are the most susceptible of all the cucurbitaceous crops and downy mildew has been observed on cucumbers in most of Asia, Africa, Europe, Australia and a significant number of countries.

Downy mildew of cucumber is caused by *Pseudoperonospora cubensis* Rostow. The disease occurs severely in high temperature with abundant relative humidity and additional cost of fungicides, coupled with potential yield losses of up to 100 per cent caused by downy mildew, threaten the long-term viability of cucurbit crop production (Hausbeck and Cortright, 2009; Holmes and Thomas, 2006; Lebeda and Urban, 2007). Presently, very few cucumber varieties or hybrids resistant to downy mildew disease are available in India and these high yielding cultivars becoming susceptible to downy mildew making it necessary to find out resistant sources for gene introgression.

Hence, the present investigation is formulated with the following objectives:

1. Assessment and quantification of genetic variability, heritability, genetic advance and genetic advance over per cent of mean for growth and yield traits in selected cucumber genotypes.

2. Assessing the plasticity for selected fruit quality parameters in cucumber genotypes.

3. Screening of cucumber genotypes for downy mildew under natural field conditions.

II. REVIEW OF LITERATURE

The objective of the present study is to assess the extent of genetic variability, heritability (broad sense), genetic advance and genetic advance as per cent mean; character association among different traits; direct and indirect effects of different characters on yield; screening of cucumber genotypes for downy mildew incidence to estimate Per cent Disease Index (PDI).

A brief review of available literature relevant to this experiment is reviewed and presented under the following headings.

2.1 Genetic variability for growth and yield parameters

2.2 Heritability, genetic advance and genetic advance over per cent mean for growth and yield parameters

2.3 Selected fruit quality parameters

2.4 Downy mildew incidence

2.5 Correlation and path coefficient analysis

2.1 Genetic variability for growth and yield parameters

The cultivar market more produced maximum female flowers, minimum male flowers (sex ratio: 1.82), maximum number of fruit per plant (Ahmed *et al*., 2004). Singh and Lal (2005) recorded highest phenotypic coefficient of variation for node at which first female flower opens (39.54 %) followed closely by rind thickness (39.45 %) and the lowest was seen for days to last fruit harvest (3.79 %). The maximum genotypic coefficient of variation was observed in case of node at which first female flower opens (35.70 %) followed by rind thickness (34.94 %) and the minimum for days to last fruit harvest (3.06 %) in muskmelon.

The highest GCV (42.79 %) and PCV (44.46 %) were observed for fruit yield in chow chow (Rai *et al*., 2005). Rakhi and Rajamony (2005) revealed highest GCV and PCV for yield per plant followed by fruit weight, fruit per plant, keeping quality of fruits and 1000 seed weight.

The genotypic coefficient of variation ranged from 4.49 % for number of leaves at 2 weeks to 158.81 % for days to 50 per cent flowering while phenotypic coefficient of variation ranged from 13.34 % to 187.96 % for the same traits respectively (Afangideh and Uyoh, 2007).

High GCV and PCV was observed for fruit diameter, number of fruit per plant and weight per fruit in bitter gourd (Islam *et al*., 2009).

Fifty eight long type cucumber accessions were evaluated for variability, character association and yield performance and results revealed highest GCV for yield per Plant (42.75 %), number of fruits per plant (33.41 %), fruit length (27.57 %), number of lateral shoots (24.19 %), average fruit weight (22.14 %), Petiole length (16.10 %), node order at which male and female flower opened (13.28 % and 12.62 %) were recorded (Hossain *et al*., 2010). The phenotypic coefficient of variation ranged between 3.6-52 %, while GCV ranged between 3.21-51 % for seed yield per plant, number of fruits per plant and fruit yield per plant. Heritability estimate was high for seed yield per plant (83-98 %), expected genetic advance in seed yield per plant ranged between 25.90-48.40 % in egusi melon (Ogbonna and Obi, 2010).

Moderate PCV and GCV were observed for number of good fruits per vine and total number of fruits per plant followed by BGDL × Hyderabad cucumber and BGDL × Hot season (Kumar *et al.,* 2011a).

Choudhary *et al.* (2011) assessed genetic variability in muskmelon genotypes where PCV was the highest for yield per plant (59.65 %) followed by flesh weight (50.96 %) and average fruit weight (46.17 %). The lowest value of PCV was obtained for days to female flower anthesis (5.12 %). The GCV was highest for yield per plant (53.41 %) followed by flesh weight per fruit (38.36 %), average fruit weight (34.08 %).

The genotypic coefficients of variation were lower ranging from 5.12 to 24.12 per cent while PCV ranged from 11.83 to 35.24 per cent. High PCV and GCV were observed for length of fruit, yield of fruit, total number of fruits per plant, total number of first male flower opening in snake gourd (Rana and Pandit, 2011). The highest phenotypic and genotypic coefficients of variation were observed for length of fruit, number of fruits per vine, weight of fruit and node number of first female flower in cucumber (Gaikwad *et al*., 2011)

Genotypic and phenotypic coefficients of variation were highest for node at first female flower appearance followed by node at first male flower appearance, yield per plant, seed cavity breadth, average fruit weight and number of fruits per plant (Veena *et al*., 2012).

Assessment of genetic variation in cucumber by Golabadi *et al.* (2012) showed a broad phenotypic variation for traits, such as total fruit yield per pickling ranged from 474.3 g (Gohar) to 338.3 g (Tornado). Genotypes Gohar, Adrian451, Green majic, Sina had the highest total fruit yield per pickling.

Performance studies revealed that the bottle gourd genotypes Gaja, NS-421, NBBL-12, Sharada, INDAM-204, NS-443, Super Dhana, Arka Bahar and Krushi Sampada were found promising for fruit yield and Anand, Gaja, Gutkha and NS-443 for seed yield (Harika *et al*., 2012).

The estimates of PCV were highest for fruit yield (28.30 %), fruit cavity length (28.20 %) and rind thickness (26.39 %), while lowest for days to appearance of first pistillate flower (7.77 %), days to last fruit harvest (8.97 %) and days to first fruit harvest (9.64 %). The estimates of GCV were highest for fruit cavity length (26.66 %), average fruit weight (22.82 %) and rind thickness (22.14 %), while lowest for days to last fruit harvest (3.90 %), days to first fruit harvest (3.99 %) and days to appearance of first pistillate flower (5.78 %) in muskmelon (Reddy *et al*., 2013).

Highest genotypic coefficient of variation was evident in number of primary branches (27.65 %) followed by node at which first female flower appears (20.77 %), fruit yield per plant (20.37 %) and fruit length (19.71 %). High phenotypic coefficient of variation was observed in number of primary branches (27.88 %), node at which first female flower appears (20.92 %), fruit yield per plant (20.90 %) and fruit length (20.45 %) in spine gourd (Khan *et al*., 2009; Basumatary *et al*., 2014).

2.2 Heritability, genetic advance and genetic advance over per cent mean for growth and yield parameters

Review of literature on heritability, genetic advance and genetic advance over per cent mean for growth and yield parameters has been presented in Table 1.

2.3 Fruit quality parameters

2.3.1 Moisture content

Tomar and Bhalala (2006) noticed good combining ability for fruit moisture in Punjab Sunheri, Pusa Madhuras, AMM-00-11, AMM-01-18, DM-1, PMM-96-20, Hara Madhu, RM-50. Significant variation for moisture (per cent) was recorded in muskmelon (Tomar *et al*., 2008).

Mehta *et al*. (2009) evaluated 44 genotypes of muskmelon, they found variation in moisture per cent ranging from 86.5 to 91.7; genotypic and phenotypic coefficients of variation were 1.54 and 1.68 per cent respectively. It has recorded high heritability (broad sense) of 84.59 per cent associated with low genetic advance as per cent mean (2.98 %).

2.3.2 Shelf life

Fruit of *Cucurbita ficifolia* have a very long storage life; fruit remain in sound condition for over a year when stored at room temperature (Robinson, 1987). Fruits of muskmelon were stored well under room temperature for about 5 days (Augustin *et al*., 1988).

Wehner *et al*. (2000) screened cucumber germplasm collection for fruit storage ability, lowest fruit weight loss (<10 %) was recorded in PI 172839, PI 344067, PI 264667, PI 171612, PI 339245, PI 220171, PI 279469 and PI 368550 whereas PI 357864 cultigen has highest fruit loss (70 %).

Rakhi and Rajamony (2005) evaluated 42 culinary melon land races for keeping quality and reported high GCV (35.45 %), PCV (36.58 %), heritability (93.89 %) and

Table 1: Literature on heritability, genetic advance and genetic advance as per cent mean for growth and yield parameters

Sl. No.	Character	Crop	Heritability (broad sense)	Genetic advance	Genetic advance as % of mean	Author
1.	**Vine length (cm)**	Cucumber	Moderate	0.34	Moderate	Kumar *et al*., 2008
		Cucumber	Low	3.11	Low	Singh *et al.,* 2011
		Cucumber	High	13.42	Low	Arunkumar *et al*., 2011
		Cucumber	High	0.33	Moderate	Yadav *et al*., 2009 Yadav *et al*., 2012
		Cucumber	Moderate	12.20	Moderate	Ullah *et al*., 2012
		Cucumber	High	135.12	High	Uddin *et al*., 2006
		Cucumber	Moderate	-	High	Veena *et al*., 2012
		Bottle gourd	Moderate	0.39	-	Kumar *et al*., 2011b
		Bottle gourd	High	-	High	Sharma and Sengupta, 2013
		Bitter gourd	High	54.54	High	Singh *et al*., 2014
		Muskmelon	High	0.37	High	Singh and Lal, 2005
		Ridge gourd	High	78.26	High	Dubey *et al*., 2013
		Snake gourd	High	-	High	Rahman *et al*., 2002
2.	**Number of branches per plant**	Cucumber	High	1.11	High	Kumar *et al*., 2009
		Cucumber	High	0.91	Moderate	Arunkumar *et al*., 2011
		Cucumber	High	1.08	High	Kumar *et al*., 2008
		Bottle gourd	Low	0.35	-	Kumar *et al*., 2011b
		Bitter gourd	High	5.36	High	Singh *et al*., 2014
		Fluted Pumpkin	High	3.41	-	Fayeun *et al*., 2012
		Ridge gourd	Moderate	0.42	Moderate	Dubey *et al*., 2013
		Snake gourd	Low	0.84	-	Ahsan *et al*., 2014
3.	**Number of nodes per vine**	Cucumber	High	-	High	Veena *et al*., 2012
		Cucumber	High	2.08	Low	Arunkumar *et al*., 2011
4.	**Internodal length**	Fluted Pumpkin	Moderate	2.52	-	Fayeun *et al*., 2012

	(cm)	Culinary melon	Moderate	-	Moderate	Rakhi and Rajamony, 2005
5.	**Node of first female flower appearance**	Cucumber	Moderate	1.23	High	Kumar *et al*., 2009
		Cucumber	High	2.21	High	Uddin *et al*., 2006 Veena *et al*., 2012
		Cucumber	High	3.19	High	Gaikwad *et al*., 2011
		Cucumber	High	0.89	High	Kumar *et al*., 2008
		Cucumber	High	0.94	High	Yadav *et al*., 2012
		Muskmelon	High	3.06	High	Singh and Lal, 2005
		Muskmelon	High	2.54	High	Torkadi *et al*., 2007
		Muskmelon	High	2.08	-	Pandey *et al*., 2005
		Snake gourd	Low	0.86	-	Ahsan *et al*., 2014
		Ridge gourd	High	7.66	Moderate	Dubey *et al*., 2013
		Snake gourd	Moderate	-	Low	Rana and Pandit, 2011
6.	**Node of first male flower appearance**	Cucumber	High	0.94	High	Kumar *et al*., 2009
		Cucumber	High	1.22	High	Kumar *et al*., 2008
		Cucumber	Moderate	-	High	Veena *et al*., 2012
		Snake gourd	Low	0.89	-	Ahsan *et al*., 2014
		Snake gourd	Low	-	Low	Rana and Pandit, 2011
7.	**Node of first female flower appearance**	Cucumber	Low	11.48	High	Kumar *et al*., 2009
		Cucumber	High	6.38	Moderate	Kumar *et al*., 2008
		Cucumber	High	12.92	Moderate	Uddin *et al*., 2006
		Cucumber	High	-	High	Veena *et al*., 2012
		Cucumber	High	3.73	-	Kumar *et al*., 2013b
		Cucumber	High	11.48	High	Gaikwad *et al*., 2011
		Cucumber	High	3.56	Low	Arunkumar *et al*., 2011
		Cucumber	Moderate	1.23	High	Yadav *et al*., 2012
		Bitter gourd	High	9.88	High	Singh *et al*., 2014
		Muskmelon	High	6.66	Moderate	Singh and Lal, 2005
		Muskmelon	High	39.53	-	Tomar *et al*., 2008

		Pumpkin	High	4.94	Low	Aktar *et al*., 2013
		Snake gourd	Low	6.31	-	Ahsan *et al*., 2014
		Snake gourd	Moderate	-	Low	Rahman *et al*., 2002
8.	**Days to first male flower anthesis**	Cucumber	High	6.48	Moderate	Kumar *et al*., 2009
		Cucumber	High	6.13	Moderate	Kumar *et al*., 2008
		Cucumber	High	-	High	Veena *et al*., 2012
		Cucumber	High	4.13	Moderate	Arunkumar *et al*., 2011
		Cucumber	High	8.7	High	Gaikwad *et al*., 2011
		Pumpkin	High	10.73	Moderate	Aktar *et al*., 2013
		Ridge gourd	High	7.01	High	Dubey *et al*., 2013
		Snake gourd	Low	4.31	-	Ahsan *et al*., 2014
		Snake gourd	High	-	Moderate	Rahman *et al*., 2002
9.	**Number of female flowers per plant**	Cucumber	High	6.79	Moderate	Uddin *et al*., 2006
		Cucumber	High	3.56	Low	Arunkumar *et al*., 2011
		Pumpkin	High	4.34	High	Aktar *et al*., 2013
		Pumpkin	High	-	-	Aruah *et al*., 2011
10.	**Number of male flowers per plant**	Cucumber	High	18.94	Moderate	Arunkumar *et al*., 2011
		Pumpkin	High	25.41	High	Aktar *et al*., 2013
		Pumpkin	Low	-	-	Aruah *et al*., 2011
11.	**Days to 50% flowering**	Cucumber	High	6.79	-	Afangideh and Uyoh, 2007
		Muskmelon	High	6.65	-	Pandey *et al*., 2005
		Snake gourd	Moderate	-	Moderate	Rana and Pandit, 2011
		Pumpkin	High	-	-	Aruah *et al*., 2011
12.	**Sex ratio**	Culinary melon	High	48.96	-	Rakhi and Rajamony, 2005
13.	**Days to first fruit harvest**	Cucumber	High	6.60	Moderate	Kumar *et al*., 2009
		Cucumber	High	13.16	High	Uddin *et al*., 2006
		Cucumber	High	-	High	Veena *et al*., 2012
		Cucumber	High	5.21	Moderate	Kumar *et al*., 2009

		Cucumber	High	11.78	High	Gaikwad *et al*., 2011
		Muskmelon	Low	6.62	Low	Singh and Lal, 2005
		Muskmelon	Low	1.93	Low	Torkadi *et al*., 2007
		Ridge gourd	High	11.6	High	Dubey *et al*., 2013
		Snake gourd	Moderate	-	Moderate	Rana and Pandit, 2011
14.	**Number of fruits per plant**	Cucumber	High	3.45	High	Kumar *et al*., 2009
		Cucumber	High	2.74	High	Gaikwad *et al*., 2011
		Cucumber	High	2.95	High	Kumar *et al*., 2008
		Cucumber	High	5.89	High	Ullah *et al*., 2012
		Cucumber	Moderate	2.27	High	Uddin *et al*., 2006
		Cucumber	High	-	High	Veena *et al*., 2012
		Muskmelon	High	50.54	-	Tomar *et al*., 2008
		Muskmelon	High	4.67	High	Torkadi *et al*., 2007
		Cucumis sativus var.hardwickii R.	High	8.8	High	Munshi *et al*., 2007
		Bitter gourd	High	0.91	High	Singh *et al*., 2014
		Muskmelon	Moderate	0.63	Low	Singh and Lal, 2005
		Pumpkin	Low	-	-	Aruah *et al*., 2011
		Ridge gourd	High	5.26	High	Dubey *et al*., 2013
		Ezyptian sweet melon	High	-	High	Ibrahim, 2012
		Snake gourd	High	-	High	Rahman *et al*., 2002
15.	**Fruit yield per plant (kg)**	Cucumber	High	0.98	High	Ullah *et al*., 2012
		Cucumber	High	1.04	High	Uddin *et al*., 2006
		Cucumis sativus var. hardwikii R.	High	38.1	High	Munshi *et al*., 2007
		Cucumber	High	1.12	Moderate	Arunkumar *et al*., 2011
		Muskmelon	Moderate	0.77	High	Singh and Lal, 2005
		Muskmelon	High	65.93	-	Tomar *et al*., 2008
		Muskmelon	High	0.66	-	Pandey *et al*., 2005

		Pumpkin	High	-	-	Aruah *et al*., 2011
		Ezyptian sweet melon	High	-	High	Ibrahim, 2012 Rahman *et al*., 2002
		Ridge gourd	High	1.37	High	Dubey *et al*., 2013
16.	**Average fruit weight (g)**	Cucumber	High	38.84	High	Kumar *et al*., 2009
		Cucumber	High	121.07	High	Ullah *et al*., 2012 Kumar *et al*., 2013b
		Cucumber	High	36.63	High	Kumar *et al*., 2008
		Cucumis sativus var.hardwikii R.	High	32.4	High	Munshi *et al*., 2007
		Cucumber	High	71.97	High	Uddin *et al*., 2006
		Cucumber	High	72.44	High	Gaikwad *et al*., 2011
		Cucumber	High	-	High	Veena *et al*., 2012
		Gherkin	-	78	-	Koch and Costa, 1991
		Bitter gourd	High (99.90)	22.99	High	Singh *et al*., 2014
		Muskmelon	High	367.05	High	Singh and Lal, 2005
		Muskmelon	High	36.56	-	Tomar *et al*., 2008
		Muskmelon	High	0.31	-	Pandey *et al*., 2005
		Pumpkin	Moderate	0.53	High	Aktar *et al*., 2013
		Ridge gourd	Moderate	17.06	Low	Dubey *et al*., 2013
		Ezyptian sweet melon	High	-	High	Ibrahim, 2012
		Snake gourd	High	-	Moderate	Rahman *et al*., 2002
		Teasel gourd	High	13.93	High	Naik *et al*., 2012
17.	**Fruit length (cm)**	Cucumber	High (100%)	5.72	High	Kumar *et al*., 2009
		Cucumber	High	6.93	Moderate	Ullah *et al*., 2012
		Cucumber	High	5.27	High	Kumar *et al*., 2008
		Cucumber	High	5.64	-	Kumar *et al*., 2013b
		Cucumber	High	11.57	High	Uddin *et al*., 2006
		Cucumber	Moderate	1.77	Low	Arunkumar *et al*., 2011

		Cucumber	High	9.50	High	Gaikwad *et al*., 2011
		Cucumber	High	-	High	Veena *et al*., 2012
		Muskmelon	Low	39	-	Tomar *et al*., 2008
		Muskmelon	High	9.98	High	Torkadi *et al*., 2007
		Bottle gourd	High	14.40	-	Kumar *et al*., 2011a
		Bitter gourd	High	9.68	High	Singh *et al*., 2014
		Pumpkin	High	4.81	High	Aktar *et al*., 2013
		Ridge gourd	High	4.56	High	Dubey *et al*., 2013
		Snake gourd	High	-	High	Rahman *et al*., 2002
		Egyptian sweet melon	High	-	High	Ibrahim, 2012
		Teasel gourd	High	0.96	Moderate	Naik *et al*., 2012
18.	**Fruit diameter (cm)**	Cucumber	High	0.80	High	Kumar *et al*., 2009 Kumar *et al*., 2008
		Cucumber	High	1.02	High	Ullah *et al*., 2012
		Cucumber	High	-	High	Veena *et al*., 2012
		Cucumber	High	1.25	High	Arunkumar *et al*., 2011 Kumar *et al*., 2013
		Cucumber	High	0.89	High	Gaikwad *et al*., 2011
		Bitter gourd	High	1.61	High	Singh *et al*., 2014
		Muskmelon	High	3.87	High	Torkadi *et al*., 2007
		Muskmelon	High	2.98	-	Pandey *et al*., 2005
		Pumpkin	Moderate	4.04	High	Aktar *et al*., 2013
		Pumpkin	High	-	-	Aruah *et al*., 2011
		Snake gourd	Moderate	-	Moderate	Rahman *et al*., 2002
		Bottle gourd	High	8.20	-	Kumar *et al*., 2011b
		Ridge gourd	High	1.43	High	Dubey *et al*., 2013
19.	**Fruit flesh thickness (cm)**	Cucumber	Moderate	0.17	Moderate	Ullah *et al*., 2012
		Cucumber	High	0.11	High	Yadav *et al*., 2012
		Cucumber	High	-	High	Veena *et al*., 2012

		Cucumber	High	0.23	High	Gaikwad *et al*., 2011
		Muskmelon	High	20.02	-	Tomar *et al*., 2008
		Muskmelon	High	1.14	High	Torkadi *et al*., 2007
		Muskmelon	High	0.84	-	Pandey *et al*., 2005
		Snake gourd	High	-	High	Rahman *et al*., 2002
		Ezyptian sweet melon	High	-	High	Ibrahim, 2012
		Pumpkin	High	1.80	High	Aktar *et al*., 2013
20.	**Fruit cavity at edible stage (cm)**	Cucumber	High	0.11	High	Kumar *et al*., 2009 Kumar *et al*., 2008
		Muskmelon	High	74.39	High	Torkadi *et al*., 2007
21.	**Number of seeds per fruit**	Cucumber	High	-	High	Veena *et al*., 2012
		Bottle gourd	High	224.75	-	Kumar *et al*., 2011b
		Bitter gourd	High	6.34	High	Singh *et al*., 2014
		Pumpkin	High	-	-	Aruah *et al*., 2011
		Snake gourd	Moderate	-	High	Rana and Pandit, 2011
		Culinary melon	High	-	High	Rakhi and Rajamony, 2005
		Snake gourd	High	-	High	Rahman *et al*., 2002
22.	**100 seed weight (g)**	Cucumber	High	0.63	High	Kumar *et al*., 2009 Kumar *et al*., 2008 Yadav *et al*., 2012
		Cucumber	High	-	High	Veena *et al*., 2012
		Muskmelon	High	1.13	High	Torkadi *et al*., 2007

GAM (70.87 %). BNG-3 and BNG-4 genotypes of coccinia recorded highest shelf life of 13 and 14 days respectively (Dharmatti *et al*., 2008).

Summer Khira was best general combiner and Summer Khira x KH-1 showed highest shelf life of fruit. (Brar *et al.*, 2011).

2.3.3 Pulp texture

Pulp texture of fruit has been recorded based on DUS guidelines that are crispy or mealy.

2.4 Downy mildew screening

Labeda (1991) studied the resistance of six muskmelon lines to eight isolates of cucurbit downy mildew originating from cucumber. Only MR-1 line was highly resistant with expression of race specificity and genetic heterogeneity.

Dhiman *et al.* (1995) evaluated four muskmelon genotypes (the open pollinated varieties, MR-12, Hara Madhu and Punjab Sunheri and F_1 hybrid and Punjab hybrid) for their reactions to downy mildew, powdery mildew and mosaic. They found that MR-12 was highly resistant to all the diseases. Minimum downy mildew incidence of bitter gourd was observed in CO-1 (12.90 %) followed by Panruthy (18.60 %) and Chidambaram Small (19.93 %) whereas, maximum was recorded in Arka Harit (71.49 %).

Kagadi *et al.* (2001) noticed that two varieties of ridge gourd Kerala-2 and Kerala-1 were highly resistant to downy mildew. The cultivars KRG-5, CH-RG-1 and CH-RG-2 were moderately resistant, while the varieties PRG-6 and DPL-RG-2 were highly susceptible to downy mildew disease.

In muskmelon, the per cent disease index for downy mildew ranged from 9.27 per cent in Haryana Local to 35.34 per cent in Delhi Local with an average of 16.95 per cent (Vishwanatha, 2003). The downy mildew incidence intensity in ridge gourd ranged from 16.70 to 31.55 in the studies of Kantharaja (2003).

The downy mildew incidence ranged from 12.9 per cent (CO-1) to 71.5 per cent (Arka Harit) with mean 33.35 per cent evaluated by Vijaykumar (2007).

Pandey *et al.* (2008) evaluated 29 genotypes of cucumber and noticed DC-l as resistant, B-184 and B-157 as highly resistant *and* DRlNKV/02-91, CH-20, FZCU-4, VRC-7 were observed to be susceptible. Only one genotype i.e. Baramasi was found to be highly susceptible.

Muskmelon lines IC 274014, IC 267397, MCPS-2, and Mehna Chibber were highly resistant (HR) to downy mildew with the disease severity of 2.0, 2.0, 1.6, and 2.8 per cent respectively (Goswamy *et al.,* 2011).

Wild species *Cucumis hardiwickii*-14 and 15*, Cucumis sativus* var. *sativus* and SM 12735 exhibited a high level of resistance to downy mildew diseases with 0-25 % PDI under natural conditions (Pitchaimuthu *et al.,* 2012).

Inbred line Ames 2354 showed a low degree of disease symptoms whereas PI 175695 exhibited high susceptibility (Kozik *et al.,* 2013). Waris *et al.* (2014) screened seven cucumber varieties and the results showed Super green special variety as moderately resistant; Beithoalfa, Marketmore-76, Cucumber 363 as moderately susceptible; Anmol, Market more and Desi as highly susceptible.

2.5 Correlation and path coefficient analysis

Traits like number of male flowers per plant, days to first male flower, days to first female flower and node number of first female flower appearance exhibited negative correlation coefficient with yield (Bhave *et al.,* 2003; Dey *et al*., 2005). Branches per plant have negative correlation with the total number of fruits per plant (Cramer and Wehner, 2000).

Length of fruit in bottle gourd exhibited a positive and significant association with fruit weight number of seeds per fruit, number of fruits per vine both at phenotypic and genotypic levels. Fruit length exhibited a significant and negative correlation with fruit diameter (0.1518) and fruit flesh thickness (0.2588). Positive and significant association of fruit weight was recorded with number of seeds per fruit and vine length and negative genotypic levels (Suchitra and Haribabu, 2006).

Significant positive relation between fruit weight with fruit length (0.45), fruit diameter (0.43) and flesh thickness (0.60) were recorded in Iranian melon cultivars (Nasrabadi *et al*., 2012). Days to first fruit harvest were negatively correlated with total yield of plant (Dubey *et al.*, 2013; Kumar *et al*., 2008; Rana and Pandit, 2011; Hossain *et al*., 2010).

Correlation studies in snake gourd by Rana and Pandit (2011) has revealed that fruit yield had significant positive correlation with total number of fruits (0.741), total number of primary branches (0.66) and total number of nodes (0.493).

The maximum positive inter correlation was observed between number of female flowers per vine and number of fruits per vine whereas sex ratio had recorded the maximum negative inter correlation with the number of female flowers per vine in bitter gourd (Sundaram, 2010). Fruit length (0.588), fruit girth (0.852), average fruit weight (0.631), seeds per fruit (0.688) and 1000-seed weight (0.77) had positive and significant correlation with yield of ash gourd at both phenotypic and genotypic level. The positive direct effect on yield was revealed by fruit length, average fruit weight and fruits per plant (Resmi and Sreelathakumary, 2012).

Number of fruits per plant and fruit weight exhibited highest direct effects (Kumar and Singh, 1998; Ram *et al.,* 2005; Raja *et al*., 2006; Nikhil and Hossain, 2007). Number of fruits per plant had highest direct effect on yield per plant at both genotypic and phenotypic levels. Number of fruits per plant also showed positive and highly significant correlation with yield (0.942). The highest negative indirect effect was recorded by days to 50 per cent flowering *via* number of fruits per plant and fruit breadth *via.,* number of fruits per plant (Singh *et al*., 2012).

Yield of muskmelon has positive and significant correlation with fruit weight (0.57), fruit diameter (0.44), fruit length (0.56), flesh thickness (0.49) and rind thickness (0.49) at both phenotypic and genotypic level. Higher and positive direct effect on yield was exerted by fruit diameter followed by number of fruits, fruit weight and rind thickness (Pandey *et al*., 2005). Negative association of number of primary branches with yield of the plant was revealed by Kumar *et al*. (2013a) in sponge gourd and Islam *et al*. (2009) in bitter gourd.

Fruit yield had a positive correlation with vine length, the number of primary branches per vine, fruit length, fruit diameter, average fruit weight, number of fruits per vine, fruit cavity length, fruit cavity width, rind thickness and seed yield in muskmelon (Reddy *et al*., 2013).

Dubey *et al.* (2013) revealed that fruit yield per plant in ridge gourd showed positive and significant correlation with number of fruits per plant (0.963), fruit length (0.892), fruit weight (0.835) and vine length (0.614) at genotypic level. Whereas number of fruits per plant (0.854), fruit length (0.721), fruit weight (0.577) and vine length (0.349) at phenotypic level. Number of fruits per plant made maximum direct contribution and also exerted indirect influence towards fruit yield per plant via fruit weight (Sahni *et al*., 1985; Varalakshmi *et al.,* 1995; Rao *et al.,* 2000; Prasanna *et al.,* 2002). Whereas days to first female flower anthesis, days to first male flower anthesis and days to first fruit harvest were negatively correlated with total yield of plant (Dubey *et al.*, 2013; Suchitra and Haribabu, 2006; Rahman *et al*., 2002).

Positive and highly significant correlation were observed between average fruit weight (r_p=0.720) and average fruit weight (r_g=0.601). Average fruit weight (0.284) and number of seeds per fruit (0.303) showed negative and significant association with root diameter in anchote (Wondimu *et al*., 2014).

Genotypic correlation were higher than their corresponding phenotypes for all the traits studied in bitter gourd (Srivastva and Srivastva , 1976; Singh *et al*., 1977; Indresh,1982, Lawande and Patil, 1989, Panthi *et al*., 1995 and Singh *et al*., 2013) for yield per plant. Yield per plant showed significant positive association with plant height, fruit diameter, fruit length and seeds per fruit. Fruit weight had a positive significant correlation with fruit diameter, fruit length and fruits per plant. Seeds per fruit have positive significant correlation with days to first flower anthesis (0.569), plant height (0.541), fruit diameter (0.745), fruit length (0.533) and fruits per plant (0.477). Plant height had a significant positive correlation with only for days to first flower anthesis (0.540) whereas edible maturity had positive significant correlation with days to first flower anthesis (0.499) (Singh *et al*., 2014).

Correlation and path coefficient analysis in spine gourd revealed that fruiting period and number of fruits per plant had positively significant correlation and also positively direct effect on it. Days to first fruit harvest had positively moderate effect on fruit yield (Aliya *et al.,* 2014). Basumatary *et al*. (2014) revealed highly significant and positive correlation of yield per plant with number of primary branches (0.75), internode length (0.73), fruits per plant (0.84), fruit diameter (0.73) and single fruit weight (0.74). Days to 50% flowering exhibited significant positive correlation with total soluble sugar (0.72) in spine gourd.

Yield per plant had highly significant and positive association with the number of fruits per plant, average weight fruit (0.535) and vine length (0.362) at the time of harvest. A negative association with sex ratio (-0.270) was also noticed. Number of fruits per plant and average weight fruit directly contributed to the yield of ash gourd and the flesh thickness indirectly effected yield (Dewan *et al*., 2014). Days to 50 per cent flowering was negatively correlated with total yield of plant (Basumatary *et al*., 2014; Rana and Pandit, 2011; Afangideh and Uyoh, 2007).

Islam *et al*. (2009) revealed that yield per plant of bitter gourd had high positive and high significant relation with number of nodes per vine (0.854). Path coefficient analysis revealed maximum direct contribution towards yield per plant with number of fruit per plant followed by vine length in bitter gourd.

Significant correlation coefficients in a positive direction were obtained between the total yield and its contributing characters *viz.,* number of female flowers (0.561), sex ratio (0.46), no. of fruits per plant (0.591), fruit weight (0.534) and early yield (0.462) in summer squash (Marie and Mohammed, 2010). High genetic correlations between the number of fruits per plant, average fruit weight and total plant dry matter, with direct, positive effects (Grisales *et al.*, 2015). Positive correlation was determined for fruit length and leaf blade length, leaf blade width, seed length, thickness of seed, 100 seed mass and number of seeds per plant (r = 0.17-0.38) in bottle gourd (Mladenovic *et al*., 2012).

The highest direct positive effects were recorded for days to first female flower opening. Days to first female flower opening had maximum direct effect (4.232) followed by days to 50 per cent male flower opening (2.563) and days to 50 per cent fruit setting (1.845). Yield was positively correlated with fruit length (0.523) and fruit width (0.439); while fruit per plant showed positive significant correlation with vine length in cucumber (Khan *et al*., 2015).

III. MATERIAL AND METHODS

The present investigation on genetic variability and heritability for growth, yield and selected qualitative traits of cucumber genotypes was undertaken during the year 2014-2015. The details of experiment, materials used and techniques adopted in the present investigation are presented in this chapter.

3.1 Geographical location and weather condition

Both the experiments were carried at Research Block of the Department of Vegetable Science, College of Horticulture, UHS campus, GKVK, Bengaluru. The experimental plot is located at 12°58' latitude north, 77°11' longitude east and altitude 930 meters above than mean sea level and it is situated in the Eastern dry zone of Karnataka. The climatic conditions were moderate and suitable for cucumber cultivation. The details of the meteorological data on weather conditions that prevailed during the experimentation period are presented in Appendix-I.

3.2 Soil characteristics of experimental site

The soil of the experimental site was red sandy loam, friable, good water holding capacity and slightly acidic in reaction (pH 5.4).

3.3 Experiment No. 1

Genetic variability and heritability for growth, yield and selected quality traits in cucumber genotypes.

3.3.1 Material

The basic material required for conducting of Research was collected from different sources. Twenty four cucumber genotypes were used in this experiment. The details of cucumber genotypes used for the study and sources are presented in Table 2.

3.3.2 Experimental site and layout

Experiment was undertaken in *rabi* season of 2014-15 at Research Block of the Department of vegetable science, College of Horticulture, Bengaluru under open field condition. Other details of experiment are given below.

Table 2: List of cucumber genotypes used for genetic variability and downy mildew disease screening

Sl. No.	Genotypes	Source
1	TMG-1	College of Horticulture, Sirsi
2	Hassan Local	VC farm, Mandya
3	EUM-402-102	College of Horticulture, Sirsi
4	Mullu Sauthe	College of Horticulture, Bengaluru
5	Sambar Sauthe	VC farm, Mandya
6	White Long	VC farm, Mandya
7	COHC-37	College of Horticulture, Bengaluru
8	Green Long	College of Horticulture, Sirsi
9	CH-1	VC farm, Mandya
10	SWL	VC farm, Mandya
11	Green Salad	VC farm, Mandya
12	Poinsette	College of Horticulture, Sirsi
13	Himangi	HRS, Goa
14	Salad cucumber	College of Horticulture, Sirsi
15	KC-1	College of Horticulture, Sirsi
16	CH-20	IIHR, Bengaluru
17	PCUC-6	College of Horticulture, Sirsi
18	COHC-42	College of Horticulture, Bengaluru
19	NCH-1	College of Horticulture, Sirsi
20	Dharwad Local	IIHR, Bengaluru
21	IIHR-304	College of Horticulture, Sirsi
22	KH-1	College of Horticulture, Sirsi
23	IIHR-341	College of Horticulture, Sirsi
24	Sirsi Local	College of Horticulture, Sirsi
	CH-20 (Downy mildew susceptible check)	
	Poinsette (Downy mildew resistant check)	

Replication-I			Replication-II	
T_1	T_{20}		T_8	T_{23}
T_{23}	T_5		T_{15}	T_9
T_8	T_{10}		T_{12}	T_{16}
T_{16}	T_{18}		T_4	T_{21}
T_{22}	T_7		T_{10}	T_{17}
T_{12}	T_3		T_7	T_{18}
T_{21}	T_{19}		T_{22}	T_{11}
T_4	T_{24}		T_{14}	T_3
T_9	T_6		T_{20}	T_{24}
T_2	T_{13}		T_6	T_1
T_{11}	T_{20}		T_5	T_{13}
T_{14}	T_{17}		T_{19}	T_2

Fig 1. Experimental plot layout and treatment details

T_1: TMG-1
T_2: Hassan Local
T_3: EUM-402-102
T_4: Mullu Sauthe
T_5: Sambar Sauthe
T_6: White Long
T_7: COHC-37
T_8: Green long
T_9: CH-1
T_{10}: SWL
T_{11}: Green Salad
T_{12}: Poinsette
T_{13}: Himangi
T_{14}: Salad cucumber
T_{15}: KC-1
T_{16}: CH-20
T_{17}: PCUC-6
T_{18}: COHC-42
T_{19}: NCH-1
T_{20}: Dharwad Local
T_{21}: IIHR-304
T_{22}: KH-1
T_{23}: IIHR-341
T_{24}: Sirsi Local

Plate 1: General view of experimental plot

Experiment design	:	Randomized Block Design
No. of genotypes	:	24
No. of replications	:	2
Spacing	:	1.5 m×0.75 m
Total plot size	:	72 m x 15.5m=1,116 m^2
Season	:	*Rabi*

3.3.3 Cultural operations

3.3.3.1 Land preparation

The experimental land was brought to fine tilth by repeated ploughings and harrowing. Well decomposed farm yard manure at the rate of 25 tonnes per hectare was applied along with the fertilizer dose of 60:50:80 kg NPK per hectare. According to the fertilizer application schedule full doses phosphorous, potassium and half dose of nitrogen was applied as basal dose and the remaining half of nitrogen was top dressed after 30 days of transplanting.

3.3.3.2 Nursery raising and transplanting

Seeds were sown into portrays filled with coir pith. Necessary plant protection measures were taken up before and after seed sowing (Anon., 2013b). The seedlings were transplanted to main field after 15 days of sowing into main field. The experimental plot was irrigated uniformly just before transplanting and thereafter at an interval of three days depending upon the soil and climate condition.

3.3.3.3 Intercultural practices

All necessary care was taken to establish a healthy cucumber crop. Plots were kept free from weeds by hand weeding at regular intervals and prophylactic sprays taken against pest and diseases at different intervals.

Other intercultural practices were undertaken as per the package of practices for horticultural crops given by University of Horticultural Sciences, Bagalkot (Anon., 2013b).

3.4 Observations recorded

Each treatment was replicated twice consisting 10 plants in individual replication. Five representative plants from each treatment were selected randomly, tagged and observations were recorded on these plants. The data recorded on five plants from each treatment was averaged and used for statistical analysis. The details of observations recorded and techniques for recording observations were as follows.

3.4.1 Vine length (cm)

The length of the vine from the collar to the tip was measured in all the five representative plants in each treatment at final harvest. Mean was calculated and expressed in centimetres.

3.4.2 Number of branches per plant

The total number of branches was counted at final harvest in all the five representative plants in each treatment at final harvest and mean was calculated.

3.4.3 Number of nodes per vine

The number of nodes per vine on the main stem was counted at final harvesting in all the five representative plants in each treatment at final harvest and mean was calculated.

3.4.4 Internodal length (cm)

The ratio of total vine length to the number of nodes per vine in all the five representative plants in each treatment was calculated and expressed in centimetres.

3.4.5 Node of first female flower appearance

The node number from the cotyledonary leaves at which the first female flower appeared was recorded in all the five representative plants in each treatment and mean was calculated.

3.4.6 Node of first male flower appearance

The node number from the cotyledonary leaves at which the first male flower appeared was recorded in all the five representative plants in each treatment and mean was calculated.

3.4.7 Days to first female flower anthesis

Number of days taken from the date of transplanting to the appearance of the first female flower on the vine was recorded in all the five representative plants in each treatment and mean was calculated.

3.4.8 Days to first male flower anthesis

Number of days taken from the date of transplanting to the appearance of the first male flower on the vine was recorded in all the five representative plants in each treatment and mean was calculated.

3.4.9 Days to 50 per cent flowering

Number of days taken from the date of transplanting to the appearance of the female flower on 50 per cent of the population in each treatment was recorded and mean was calculated.

3.4.10 Number of female flowers per plant

The number of female flower throughout the life cycle of vine was counted as and when they appear by regular observations in all the five representative plants in each treatment and mean was calculated.

3.4.11 Number of male flowers per plant

The number of male flower throughout the life cycle of vine was counted as and when they appear by regular observations in all the five representative plants in each treatment and mean was calculated.

3.4.12 Sex ratio

The ratio of female to male flowers was calculated from the recorded female and male flowers per vine in all the five representative plants in each treatment and mean was calculated.

3.4.13 Days to first fruit harvest

Number of days taken from the date of transplanting to first fruit harvest was recorded in all the five representative plants in each treatment and mean was calculated.

3.4.14 Number of fruits per plant

The number of fruits per vine overall the harvests were counted in all the five representative plants in each treatment and mean was calculated.

3.4.15 Average fruit weight (g)

The weight of five individual fruits harvested at the edible stage was recorded. The average weight of the fruit was calculated and expressed in grams.

3.4.16 Fruit yield per plant (kg)

The weight of all the fruits per vine was recorded in all the five representative plants in each treatment. Mean was calculated and expressed in kilo grams.

3.4.17 Fruit length (cm)

Length of five fruits harvested at edible maturity was recorded from base to the apex of fruit in all the five representative plants in each treatment. Mean was calculated and expressed in centimetres.

3.4.18 Fruit diameter (cm)

Diameter of the same five fruits selected for recording the length, was measured in centimetre at maximum thickness with the help of Vernier calliper. Mean was calculated and expressed in centimetres.

3.4.19 Fruit flesh thickness (cm)

The flesh thickness without the skin was measured. Mean was calculated and expressed in centimetres.

3.4.20 Fruit cavity at harvesting (cm)

The flesh thickness without the skin was measured using Vernier calliper by cutting the fruit in equatorial plane. Mean was calculated and expressed in centimetres.

3.4.21 Number of seeds per fruit

Number of seeds was counted in the representative fruits and mean was calculated.

3.4.22 100 seed weight (g)

Weight of 100 seeds was recorded using a high precision digital weighing balance. Mean was calculated and expressed in grams.

3.4.23 Fruit moisture content (%)

Moisture content of the fruit is recorded using digital moisture meter (model MA-35). Mean was calculated and expressed in per cent.

3.4.24 Shelf life (days)

To study the shelf life of fruits, five fruits were collected after harvest from each treatment and kept at room temperature. Fruits were observed for retention of freshness and firmness. Number of days the fruits were looking fresh was recorded based on visual observation and expressed in days.

3.4.25 Pulp texture

Pulp texture of fruit was recorded according to DUS guideline that is crispy or mealy.

3.5 Statistical analysis

The data recorded from representative plants were averaged and the mean values obtained were used for statistical analysis.

3.5.1 Analysis of variance

Analysis of variance for individual character was done on the basis of mean values as suggested by Panse and Sukhatme (1967). The model of analysis of variance adopted is given below.

Sources of variation	**Degrees of freedom**	**SS**	**MSS**	**F-ratio**
Replication	r-1	RSS	MSSr = $\frac{RSS}{r-1}$	MSSt/MSSe
Treatment	k-1	TrSS	MSSt = $\frac{TrSS}{k-1}$	
Error	(k-1)(r-1)	ESS	MSSe= $\frac{ESS}{(k-1)(r-1)}$	
Total	kr-1	TSS		

Where,

r= number of replications

k= number of genotypes

SS, MSSr, MSSt and MSSe = Sum of squares, mean sum of squares for replication, treatment and error respectively.

3.5.2 Estimation of genetic variability parameters

The variance due to genotype, phenotype and environment were computed as follows.

Genotypic variance ($\sigma^2 g$) = $\frac{\text{Treatment MSS} - \text{Error MSS}}{r}$

Phenotypic variance ($\sigma^2 p$) = $\frac{\text{Treatment MSS} - \text{Error MSS}}{r}$ + Error MSS or

Phenotypic variance ($\sigma^2 p$) = $\sigma^2 g + \sigma^2 e$

Where, 'r' is number of replications

3.5.3 Coefficient of variability

Genotypic and phenotypic coefficients of variation were computed according to Burton and Devane (1953).

Genotypic coefficient of variance (GCV) = $\frac{\sigma^2 g \times 100}{\bar{x}}$

Phenotypic coefficient of variance (PCV) = $\frac{\sigma^2 p \times 100}{\bar{x}}$

Where,

$\sigma^2 g$ = Genotypic variance
$\sigma^2 p$ = Phenotypic variance
$\bar{x}$= General mean

The genotypic and phenotypic coefficient of variation was categorized by Shivasubramanian and Menon (1973) as,

0-10 = Low
10-20 = Moderate
>20 = High

3.5.4 Heritability

Broad sense heritability was estimated as the ratio of genotypic variance to the phenotypic variance and was expressed in percentage (Falconer, 1981).

Heritability (h^2) = $\frac{\sigma^2 g}{\sigma^2 p} \times 100$

Where,

$\sigma^2 g$ = Genotypic variance
$\sigma^2 p$ = Phenotypic variance

The calculated heritability was classified in to three groups as suggested by Johnson *et al.* (1955);

0-30 = Low
30-60 = Moderate
>60 = High

3.5.5 Genetic advance (GA)

Genetic advance as per cent mean of each character was worked out by adopting following formula given by Johnson *et al*. (1955).

GA = $k \times h^2 \times \sqrt{\sigma^2 p}$

Where,
h^2 = Broad sense heritability
k = Selection differential (2.06) at 5 % selection intensity

$\sqrt{\sigma^2 p}$ = Phenotypic standard deviation

3.5.6 Genetic advance over per cent of mean (GAM)

Genetic advance as percentage over mean worked as suggested by Johnson *et al*. (1955).

GAM = $\frac{GA}{\bar{x}} \times 100$

Where,

GA= Genetic advance

$\bar{x}$= mean of the population

Genetic advance as percentage over mean categorized as suggested by Johnson *et al*. (1955).

0-10 = Low
10-20 = Moderate
>20 = High

3.5.7 Correlation studies

Correlation coefficients were worked out to determine the degree of association among the characters as well as yield. This was done according to the formula given by Al- Jibouri *et al.* (1958).

Genotypic correlation $r_{xy}(G) = \frac{Cov_{xy}\ (G)}{V_x(G) \times V_y(G)}$

Phenotypic correlation $r_{xy}(P) = \frac{Cov_{xy}\ (P)}{V_x(P) \times V_y(P)}$

Where,

Cov_{xy} (G) = Genotypic coefficient of variance between 'x' and 'y'
Cov_{xy} (P) = Phenotypic coefficient of variance between 'x' and 'y'
V_x (G) = Genotypic variance of character 'x'
V_x (P) = Phenotypic variance of character 'x'
V_y (G) = Genotypic variance of character 'y'
V_y (P) = Phenotypic variance of character 'y'

Test of significance of correlation was tested by comparing 'r' value with obtained value.

3.5.8 Path coefficient analysis

The estimates of direct and indirect effects were calculated by the path coefficient analysis method as suggested by Wright (1921) and illustrated by Dewey and Lu (1959).

$r_{1y} = a + r_{12}b + r_{13}c \ldots\ldots\ldots\ldots + r_{11}i$

$r_{2y} = a + r_{21}a + r_{22}b + c + r_{23}c + \ldots\ldots\ldots\ldots + r_{21}i$

$r_{3y} = r_{31}a + r_{32}b + c + \ldots\ldots\ldots\ldots + r_{31}i$

$r_{ny} = rn_{11}a + r_{12}b + r_{13}c + \ldots\ldots\ldots\ldots + I$

Where,

'r_{1y}' to 'r_{ny}' = Correlation coefficients between casual factors '1' to 'n' on dependent character 'Y'
r_{12}, r_{21}, r_{31},…. rni = Correlation coefficients between casual factors '1' to 'n'
a, b, c,……I = direct effects of characters 'a' to 'I' on dependent character Y

Residual effect (R) = 1 − $\sqrt{(a^2 + b^2 + c^2 + \ldots + i^2 + 2\text{abr}_{12} + 2\text{abr}_{13} + \ldots)}$

Lenka and Mishra (1973) have suggested a scale for the importance of direct and indirect effects values as given below:

Values of direct and indirect effects	**Rate of scale**
0.00-0.09	Negligible
0.10-0.19	Low
0.20-0.29	Moderate
0.30-0.99	High
More than 0.99	Very high

3.6 Experiment No. 2

Screening of cucumber genotypes for downy mildew disease resistance under field conditions.

3.6.1 Material

Genotypes used for this experiment were same as that of experiment No. 1 but the checks used were Poinsette (resistant) and CH-20 (susceptible). The details of the cucumber genotypes used for the study are presented along with their sources in the Table 2.

3.6.2 Methods

Experiment was undertaken in *Rabi* 2015 at research block of the Department of Vegetable Science, College of Horticulture, Bengaluru under Open field condition. The materials used are same as experiment no. 1 except that (Poinsette) and (CH-20) were used as resistant and susceptible checks respectively. Cultural operations are similar to that of experiment no. 1.

3.7 Observations recorded

3.7.1 Downy mildew disease screening

Each plant was visually assessed for percent leaf area infected, using linear 0 to 5 scale and the Per cent Disease Index (PDI) was calculated (Girisha, 1989).

0 = 0% Immune
1 = 1–10% Resistant
2 = 11– 25% Moderately resistant
3 = 26–50% Moderately susceptible
4 = 51–75% Susceptible
5 = 76-100% Highly susceptible

The Per cent Disease Index (PDI) was calculated by using the formula (McKinney, 1923)

$$\text{PDI} = \frac{\text{Sum of numerical values}}{\text{Number of leaves Graded x Maximum rating}} \times 100$$

IV. EXPERIMENTAL RESULTS

The results obtained in this study are presented under the following headings.

4.1 Performance of genotypes
4.2 Analysis of variance
4.3 Genetic components of variation
4.4 Character association among different parameters
4.5 Path coefficient analysis
4.6 Downy mildew incidence

4.1 Performance of genotypes

Genetic variability is the basic need for a plant breeder to initiate any breeding programme. Mean performance of genotypes has paramount importance in estimating various variability components to assess and understand the existing variation. All the genotypes under study showed wide variations for different traits investigated. Mean values of 24 genotypes studied for different growth, flowering, fruiting and some fruit quality parameters are presented in Table 3-7 under relevant headings.

4.1.1 Performance of genotypes for growth parameters

The vine length was maximum in Green Salad (241.95 cm) followed by IIHR-341 (233.00 cm), PCUC-6 (221.86 cm) and minimum in Dharwad Local (115.13 cm). The number of branches was highest in Dharwad Local (6.90) followed by IIHR-304 (6.00), Green Long and IIHR-341 (5.80) and minimum branches were recorded in CH-20 (2.60). The number of nodes was highest in NCH-1 (37.00) followed by CH-20 (34.90), Green Salad (33.20) and lowest nodes were recorded in Sambar Sauthe (12.70). The highest internodal length was recorded in IIHR-304 (10.96 cm) followed by Sambar Sauthe (10.26 cm) and lowest internodal length was registered in COHC-37 (3.76 cm) (Table-3).

The node of first male flower appearance was varied from 1.5 (IIHR-341) to 2.9 (Himangi) whereas node of first female flower appearance varied from 3.50 (IIHR-341)

Table 3: Performance of cucumber genotypes for different growth characteristics

Genotypes	Vine length (cm)	Number of branches per plant	Number of nodes per plant	Internodal length (cm)
TMG-1	191.00	3.70	29.40	6.45
Hassan Local	198.07	5.10	21.70	9.19
EUM-402-102	155.48	2.90	28.60	5.45
Mullu Sauthe	138.95	4.70	20.10	6.96
Sambar Sauthe	129.13	5.30	12.70	10.26
White Long	186.75	4.50	23.60	7.91
COHC-37	122.66	3.70	32.80	3.76
Green Long	213.79	5.80	22.30	8.38
CH-1	136.79	5.40	21.40	6.50
SWL	153.25	3.30	24.20	7.10
Green Salad	241.95	5.70	33.20	7.32
Poinsette	167.40	5.00	18.20	9.28
Himangi	160.50	5.10	30.50	5.29
Salad cucumber	187.55	2.90	25.70	7.32
KC-1	215.86	5.10	31.10	6.95
CH-20	176.44	2.60	34.90	5.06
PCUC-6	221.86	3.90	27.80	7.78
COHC-42	161.56	4.30	29.10	5.66
NCH-1	182.86	5.10	37.00	4.94
Dharwad Local	115.13	6.90	12.80	9.08
IIHR-304	185.20	6.00	16.80	10.96
KH-1	213.76	5.20	31.60	6.84
IIHR-341	233.00	5.80	28.80	8.15
Sirsi Local	126.96	3.90	15.10	8.45
SEm±	2.38	0.25	0.72	0.21
CD at 5%	6.96	0.73	2.11	0.61
CV (%)	1.91	7.54	4.02	4.05

Table 4: Performance of cucumber genotypes for flowering characters

Genotypes	Node of first male flower appearance	Node of first female flower appearance	Days to first male flower anthesis	Days to first female flower anthesis	Days to 50% flowering
TMG-1	2.10	6.58	34.20	40.70	41.50
Hassan Local	2.20	5.20	32.30	41.10	42.50
EUM-402-102	2.60	5.00	41.60	49.30	46.50
Mullu Sauthe	2.70	5.20	39.80	46.30	49.50
Sambar Sauthe	1.70	3.70	34.00	45.98	58.00
White Long	2.00	4.90	38.30	47.40	44.00
COHC-37	2.10	6.40	34.20	40.60	40.50
Green Long	2.20	4.00	45.10	55.40	55.50
CH-1	2.80	6.00	40.50	47.70	49.50
SWL	2.00	4.20	38.70	46.10	45.00
Green Salad	2.85	5.60	38.57	47.27	43.50
Poinsette	2.20	5.40	40.58	45.70	44.50
Himangi	2.90	5.10	32.00	40.30	52.00
Salad cucumber	2.70	5.90	42.10	51.20	50.50
KC-1	2.00	5.70	41.09	51.80	47.50
CH-20	2.35	6.50	40.00	46.50	51.50
PCUC-6	2.10	5.90	41.70	51.00	48.00
COHC-42	2.50	6.40	37.60	48.60	52.50
NCH-1	2.00	4.50	42.50	47.10	48.00
Dharwad Local	2.70	4.60	36.00	47.60	53.00
IIHR-304	2.00	5.80	40.65	46.00	46.50
KH-1	2.10	5.50	43.60	52.30	51.00
IIHR-341	1.50	3.50	38.40	45.10	46.50
Sirsi Local	2.70	3.70	35.90	42.90	45.00
SEm±	0.12	0.31	0.72	0.93	1.12
CD at 5%	0.34	0.90	2.12	2.72	3.29
CV (%)	7.05	8.34	2.64	2.80	3.28

Table 5: Performance of cucumber genotypes for number of male flowers per plant, female flowers per plant and sex ratio

Genotypes	Number of male flowers per plant	Number of female flowers per plant	Sex ratio
TMG-1	180.00	31.10	5.92
Hassan Local	115.40	18.40	6.37
EUM-402-102	163.70	24.40	6.77
Mullu Sauthe	133.70	22.70	5.90
Sambar Sauthe	166.00	31.90	5.24
White Long	142.80	29.60	4.89
COHC-37	139.30	28.80	4.92
Green Long	147.90	25.40	5.90
CH-1	130.60	23.00	5.74
SWL	139.50	30.00	4.71
Green Salad	221.50	34.90	7.25
Poinsette	154.50	35.70	4.34
Himangi	144.20	32.60	4.45
Salad cucumber	136.20	30.60	4.57
KC-1	170.80	27.40	6.29
CH-20	115.60	23.80	4.90
PCUC-6	135.60	24.20	5.76
COHC-42	149.00	25.40	6.01
NCH-1	164.80	26.20	6.32
Dharwad Local	144.00	27.10	5.42
IIHR-304	130.80	23.12	5.73
KH-1	150.80	26.40	6.42
IIHR-341	136.80	29.40	4.67
Sirsi Local	142.50	25.60	5.63
SEm±	3.69	0.92	0.19
CD at 5%	10.81	2.70	0.56
CV (%)	3.47	4.76	4.85

to 6.58 (TMG-1). Male flower appearance was earliest in Himangi (32.00 days) followed by Hassan Local (32.30 days) and late appearance was noticed in Green Long (45.10 days). Early appearance of female flower was noticed in Himangi (40.30 days) followed by COHC-37 (40.60 days), TMG-1 (40.70 days) whereas late appearance was recorded in Green Long (55.40 days). The Days taken for 50 per cent flowering was early in COHC-37 (40.50 days) followed by TMG-1 (41.50 days) whereas it was registered late in Sambar Sauthe (58.00 days) (Table-4).

The highest number of male flowers were recorded in Green Salad (221.50) followed by TMG-1 (180.00), KC-1 (170.80) whereas lowest number was recorded in Hassan Local (115.40). The highest number of female flowers was recorded in Poinsette (35.70) followed by Green Salad (34.90) whereas lowest number was recorded Hassan Local (18.40). The lowest sex ratio was noticed in Poinsette (4.34) followed by Himangi (4.45) whereas highest sex ratio was recorded in Green Salad (7.25) (Table-5).

4.1.2 Performance of genotypes for yield parameters

The days taken for first fruit harvest were early in Hassan Local (47.49 days) followed by SWL (48.90 days) and it was late in PCUC-6 (58.30 days). Fruit length was highest in COHC-42 (29.86 cm) followed by Dharwad Local (29.04 cm), Sirsi Local (28.84 cm) and lowest recorded in NCH-1 (13.80 cm). Fruit diameter was maximum in COHC-42 (7.02 cm) followed by CH-1 (6.38 cm), PCUC-6 (6.19 cm) whereas lowest diameter recorded in Hassan Local (4.23 cm). Thick flesh is noticed in in Dharwad Local (3.16 cm) followed by Sambar Sauthe (2.85 cm), IIHR-341 (2.33 cm) and low flesh thickness was recorded in CH-20 (1.08 cm). Fruit cavity at edible stage had recorded high in COHC-42 (3.48 cm) followed by Sambar Sauthe (3.31 cm), Poinsette (3.30 cm) and lowest was recorded in NCH-1 (1.18 cm).

The average fruit weight was maximum in PCUC-6 (371.93 g) followed by Mullu Sauthe (364.55 g), Dharwad Local (331.86 g) and minimum fruit weight was recorded in NCH-1 (130.50g). Highest number of fruits were documented in Hassan Local (10.50) followed by EUM-402-102 (10.20), IIHR-341(9.2) and lowest in IIHR-304 and Sirsi Local (4.60). Fruit yield was maximum in TMG-1 (3.58 kg) followed by EUM-402-102

Table 6: Performance of cucumber genotypes for fruiting characteristics

Genotypes	Days to first fruit harvest	Number of fruits per plant	Average fruit weight (g)	Yield per plant (kg)	Fruit length (cm)	Fruit diameter (cm)	Fruit flesh thickness (cm)	Fruit cavity at edible stage (cm)	Number of seeds per fruit	100 seed weight (g)
TMG-1	49.50	7.70	292.58	3.58	24.23	5.50	1.26	3.08	206.60	3.352
Hassan Local	47.49	10.50	262.21	2.23	20.59	4.23	1.38	2.60	227.70	2.879
EUM-402-102	54.80	10.20	304.76	3.38	26.40	5.20	1.35	2.95	275.70	3.503
Mullu Sauthe	52.30	5.10	364.55	1.70	19.72	5.14	1.86	3.20	294.80	2.229
Sambar Sauthe	53.28	5.20	316.87	2.42	21.44	5.92	2.85	3.31	255.50	1.953
White Long	52.10	7.60	300.34	2.16	23.19	6.10	1.63	3.18	323.80	3.109
COHC-37	49.00	5.60	267.85	1.51	23.66	5.31	1.73	3.22	181.10	2.176
Green Long	55.30	4.90	232.74	1.30	26.07	5.51	1.49	2.60	132.80	2.704
CH-1	56.00	5.00	270.74	1.58	27.19	6.38	1.91	3.12	143.80	2.994
SWL	48.90	5.10	155.34	1.16	19.19	5.06	1.80	2.23	119.10	3.201
Green Salad	54.95	7.20	311.05	2.28	28.42	6.24	1.86	2.87	268.20	3.132
Poinsette	52.00	6.30	196.63	1.49	16.69	5.49	1.21	3.31	116.60	2.314
Himangi	51.90	6.50	216.04	1.65	15.66	5.54	1.25	2.83	183.40	1.535
Salad cucumber	52.86	8.80	297.10	2.61	23.54	6.01	1.36	3.28	142.20	2.711
KC-1	54.50	5.20	256.01	1.39	26.46	5.54	1.28	2.94	286.10	3.098
CH-20	56.20	6.60	260.62	1.76	17.85	5.27	1.08	1.47	127.20	2.412
PCUC-6	58.30	6.70	371.93	2.46	18.68	6.19	1.59	3.01	173.90	2.252
COHC-42	56.90	5.50	317.68	1.69	29.86	7.02	1.72	3.48	175.20	3.091
NCH-1	58.00	6.80	130.50	1.18	13.80	4.80	1.18	2.77	98.90	2.605
Dharwad Local	56.80	8.50	331.86	2.43	29.04	5.57	3.16	3.31	255.50	1.941
IIHR-304	52.80	4.60	131.61	1.11	17.46	4.98	1.62	1.40	91.10	3.272
KH-1	56.50	4.80	241.01	1.55	25.96	5.21	1.38	2.54	241.10	3.177
IIHR-341	50.80	9.20	237.10	2.56	17.11	5.58	2.33	2.90	110.70	2.556
Sirsi Local	49.00	4.60	252.32	1.63	28.84	5.21	1.99	3.26	158.70	3.108
SEm±	0.88	0.34	3.59	0.12	0.40	0.11	0.09	0.13	5.62	0.05
CD at 5%	2.56	1.00	10.50	0.34	1.16	0.32	0.28	0.38	16.44	0.16
CV (%)	2.32	7.39	1.93	8.64	2.49	2.80	8.18	6.44	4.15	2.87

(3.38 kg), Salad cucumber (2.61 kg) and minimum yield recorded in IIHR-304 (1.11 kg). More number of seeds were recorded in White Long (323.80) followed by Mullu Sauthe (294.80), KC-1 (286.10) and minimum seeds noticed in IIHR-304 (91.10). The weight of 100 seed was highest in EUM-402-102 (3.503g) followed by TMG-1 (3.352g), IIHR-304 (3.272g) and lowest seed weight recorded in Himangi (1.535g) (Table-6).

4.1.3 Performance of genotypes for quality parameters

Fruit moisture was highest in Salad cucumber (96.78 %) followed by Green Salad (96.76 %), White Long (96.36 %) whereas lowest was recorded in COHC-37 (92.97 %). The highest shelf life of fruit was registered in Sambar Sauthe and Dharwad Local (8.10 days) followed by Green Salad and Sirsi Local (7.90 days), PCUC-6 (7.80 days) whereas lowest was recorded in IIHR-304 (4.60 days). The pulp texture was recorded using DUS guideline where it is classified into two that is crispy and mealy. All genotypes studied were recorded crispy except Himangi which is having mealy type of pulp (Table-7).

4.2 Analysis of variance

Analysis of variance was carried out for different growth, yield and quality characters of 24 cucumber genotypes to estimate the variation due to known (genotype) and unknown sources (phenotype and environment). The analysis of variance for different quantitative characters revealed that mean squares were highly significant for all the characters indicating the existence of sufficient genetic variability for all the plant characters and the variation due to replication was non-significant for all the characters. The variation in genotypes due to known and unknown sources is presented in Table-8.

4.3 Genetic components of variation

The assessment of variability present in any crop is the essential pre-requite for formulating an effective breeding programme as the existing variability can be used to enhance the yield level of the cultivars by following appropriate breeding strategies (Patil *et al*., 2012), that means genetic variability is the soul of plant breeding which is important for improvement of quantitative characters.

Table 7: Performance of cucumber genotypes for selected quality parameters in cucumber

Genotypes	Fruit moisture (%)	Shelf life (days)	Pulp texture
TMG-1	96.12	6.30	Crispy
Hassan Local	94.99	6.70	Crispy
EUM-402-102	95.61	6.10	Crispy
Mullu Sauthe	94.88	7.30	Crispy
Sambar Sauthe	95.90	8.10	Crispy
White Long	96.36	7.50	Crispy
COHC-37	92.97	5.90	Crispy
Green Long	94.96	6.50	Crispy
CH-1	93.06	7.30	Crispy
SWL	94.26	5.30	Crispy
Green Salad	96.76	7.90	Crispy
Poinsette	94.89	5.50	Crispy
Himangi	96.05	7.50	Mealy
Salad cucumber	96.78	6.20	Crispy
KC-1	93.56	6.80	Crispy
CH-20	94.58	7.40	Crispy
PCUC-6	96.11	7.80	Crispy
COHC-42	95.66	5.10	Crispy
NCH-1	95.97	4.60	Crispy
Dharwad Local	95.90	8.10	Crispy
IIHR-304	96.16	4.60	Crispy
KH-1	93.27	6.60	Crispy
IIHR-341	95.29	5.50	Crispy
Sirsi Local	93.10	7.90	Crispy
SEm±	0.29	0.30	-
CD at 5%	0.84	0.87	-
CV (%)	0.43	6.40	-

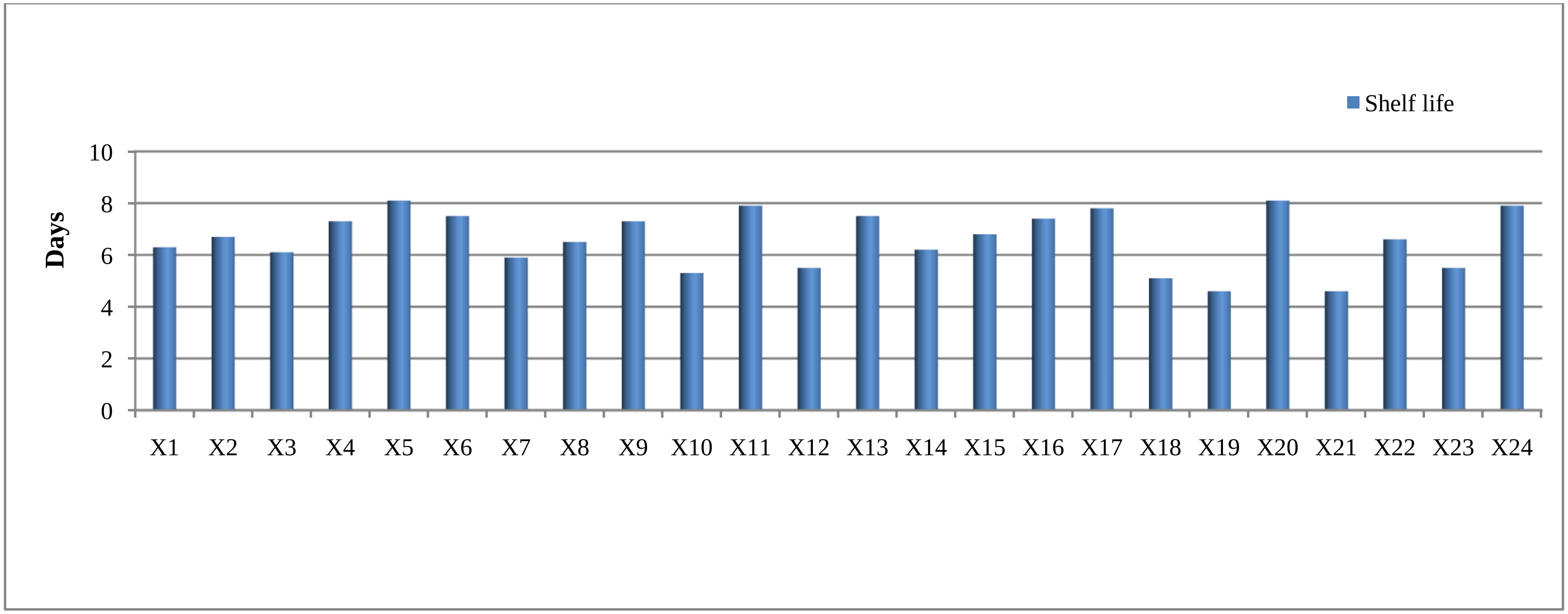

Fig. 2: Shelf life of fruit in twenty four cucumber genotypes

X_1: TMG-1
X_2: Hassan Local
X_3: EUM-402-102
X_4: Mullu Sauthe
X_5: Sambar Sauthe
X_6: White Long
X_7: COHC-37
X_8: Green Long

X_9: CH-1
X_{10}: SWL
X_{11}: Green Salad
X_{12}: Poinsette
X_{13}: Himangi
X_{14}: Salad Cucumber
X_{15}: KC-1
X_{16}: CH-20

X_{17}: PCUC-6
X_{18}: COHC-42
X_{19}: NCH-1
X_{20}: Dharwad Local
X_{21}: IIHR-304
X_{22}: KH-1
X_{23}: IIHR-341
X_{24}:Sirsi Local

Table 8: Analysis of variance for different horticultural traits in cucumber

Character	Source of variation		
	Genotype	Replication	Error
Vine length (cm)	2682.12**	26.99	11.31
Number of branches per plant	2.59**	0.00033	0.125
Number of nodes per plant	97.71**	0.61	1.04
Internodal length (cm)	6.29**	0.47	0.087
Node of first female flower appearance	1.81**	1.08	0.191
Node of first male flower appearance	0.31**	0.0008	0.027
Days to first female flower anthesis	31.15**	0.14	1.73
Days to first male flower anthesis	25.94**	0.006	1.047
Days to 50% flowering	46.05**	10.08	2.52
Number of female flowers per plant	35.10**	0.75	2.15
Number of male flowers per plant	990.20**	58.96	27.29
Sex ratio	1.24**	0.19	0.073
Days to first fruit harvest	19.57**	2.90	1.53
Fruit length (cm)	45.74**	0.09	0.31
Fruit diameter (cm)	0.68**	0.06	0.03
Fruit flesh thickness (cm)	0.52**	0.005	0.018
Fruit cavity at edible stage (cm)	0.57**	0.0001	0.034
Average fruit weight (g)	8316.47**	0.023	25.73
Total number of fruits per plant	6.38**	0.42	0.24
Yield per plant (kg)	0.88**	0.113	0.028
Number of seeds per fruit	9732.42**	18.50	63.15
100 seed weight (g)	0.55**	0.006	0.0061
Fruit moisture (%)	2.90**	0.04	0.16
Shelf life (days)	2.43**	0.07	0.18

*, ** Significant at 5% and 1% probability level respectively

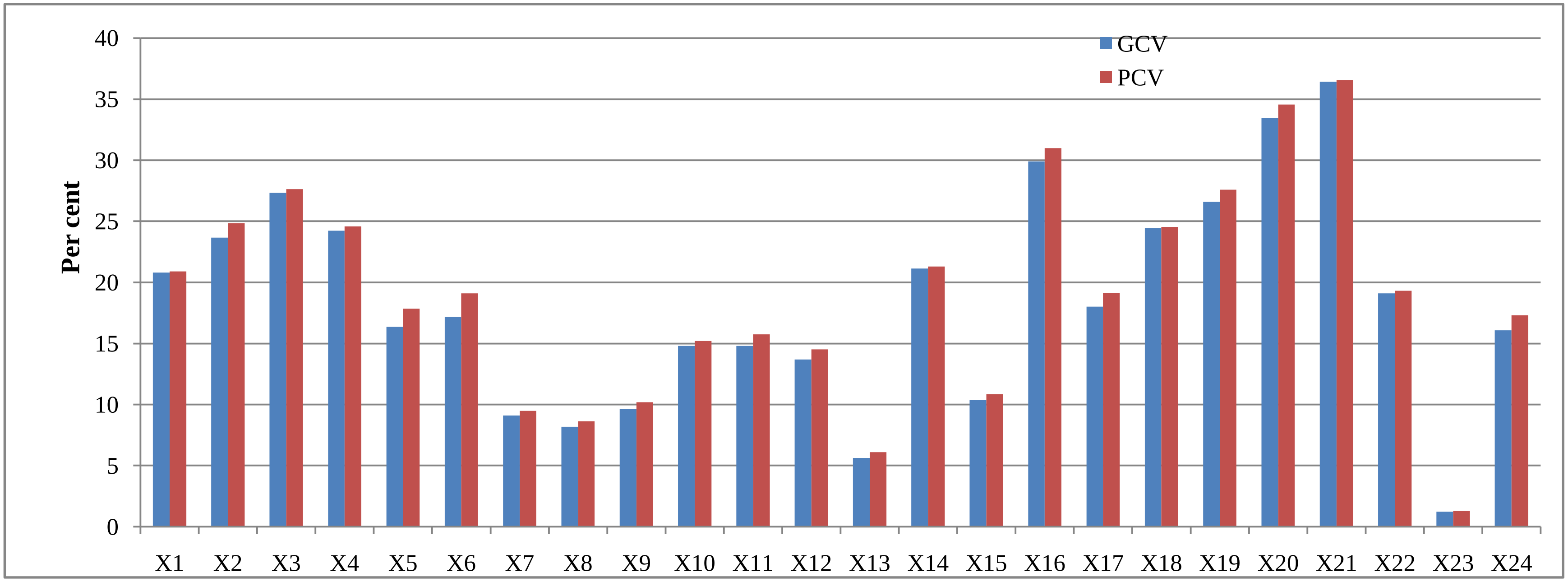

Fig. 3: Genotypic and phenotypic coefficients of variation for different characters in cucumber

X_1: Vine length
X_2: Number of branches
X_3: Number of nodes
X_4: Internodal length
X_5: Node of first male flower appe
X_6: Node of first female flower appearance

X_7: Days to first male flower anthesis
X_8: Days to first female flower anthesis
X_9: Days to 50% flowering
X_{10}: Male flowers per plant
X_{11}: Female flowers per plant
X_{12}: Sex ratio

X_{13}: Days to first fruit harvest
X_{14}: Fruit length
X_{15}: Fruit diameter
X_{16}: Fruit flesh thickness
X_{17}: Fruit cavity at edible stage
X_{18}: Average fruit weight

X_{19}: Number of fruits per plant
X_{20}: Yield per plant
X_{21}: Number of seeds per fruit
X_{22}: 100 seed weight
X_{23}: Fruit moisture
X_{24}: Shelf life

Table 9: Estimates of different genetic parameters for different traits in cucumber

Character	Mean	Range		PCV (%)	GCV (%)
		Min.	Max.		
Vine length (cm)	175.70	115.13	241.95	20.89	20.80
Number of branches per plant	4.70	2.50	6.90	24.84	23.67
Number of nodes per plant	25.40	12.70	37.00	27.63	27.34
Internodal length (cm)	7.27	3.76	10.95	24.58	24.24
Node of first male flower appearance	2.29	1.50	2.90	17.85	16.35
e of first female flower appearance	5.23	3.50	6.60	19.10	17.18
Days to first male flower anthesis	38.72	32.00	45.10	9.48	9.10
Days to first female flower anthesis	46.83	40.30	55.40	8.64	8.17
Days to 50 per cent flowering	48.02	40.50	58.00	10.19	9.64
Number of male flowers per plant	148.17	115.40	221.50	15.21	14.80
Number of female flowers per plant	27.40	18.40	35.70	15.75	14.81
Sex ratio	5.59	4.34	7.25	14.51	13.68
Days to first fruit harvest	53.34	47.50	58.30	6.09	5.63
Fruit length (cm)	22.54	13.80	29.86	21.29	21.14
Fruit diameter (cm)	5.51	4.23	7.02	10.84	10.39
Fruit flesh thickness (cm)	1.68	1.08	3.16	31.00	29.91
Fruit cavity at edible stage (cm)	2.87	1.40	3.48	19.13	18.01
Average fruit weight (g)	263.31	130.50	371.93	24.53	24.45
Total number of fruits per plant	6.60	4.60	10.50	27.60	26.60
Yield per plant (kg)	1.95	1.11	3.58	34.57	33.48
Number of seeds per fruit	191.36	91.10	323.80	36.58	36.42
100 seed weight (g)	2.72	1.53	3.50	19.32	19.10
Fruit moisture (%)	95.13	92.97	96.78	1.30	1.23
Shelf life (days)	6.60	4.60	8.10	17.30	16.07

Table 10: Estimation of heritability (broad sense), genetic advance and genetic advance as percent mean for different traits in cucumber

Characters	Heritability (%)	Genetic advance	Genetic advance as % of mean
Vine length (cm)	99.20	74.96	42.66
Number of branches per plant	90.80	2.18	46.45
Number of nodes per plant	97.90	14.17	55.72
Internodal length (cm)	97.30	3.58	49.26
Node of first male flower appearance	83.90	0.70	31.31
Node of first female flower appearance	80.90	1.67	31.84
Days to first male flower anthesis	92.20	6.98	18.00
Days to first female flower anthesis	89.50	7.47	15.92
Days to 50 per cent flowering	89.60	9.10	18.81
Number of male flowers per plant	94.60	43.97	29.66
Number of female flowers per plant	88.40	7.86	28.70
Sex ratio	88.80	1.48	26.56
Days to first fruit harvest	85.50	5.72	10.72
Fruit length (cm)	98.60	9.75	43.25
Fruit diameter (cm)	91.90	1.13	20.52
Fruit flesh thickness (cm)	93.00	1.00	59.42
Fruit cavity at edible stage (cm)	88.70	1.00	34.94
Average fruit weight (g)	99.40	132.22	50.21
Total number of fruits per plant	92.80	3.48	52.79
Yield per plant (kg)	93.70	1.30	66.77
Number of seeds per fruit	98.70	142.30	74.38
100 seed weight (g)	97.80	1.06	38.92
Fruit moisture (%)	88.30	2.28	2.39
Shelf life (days)	86.30	2.03	30.76

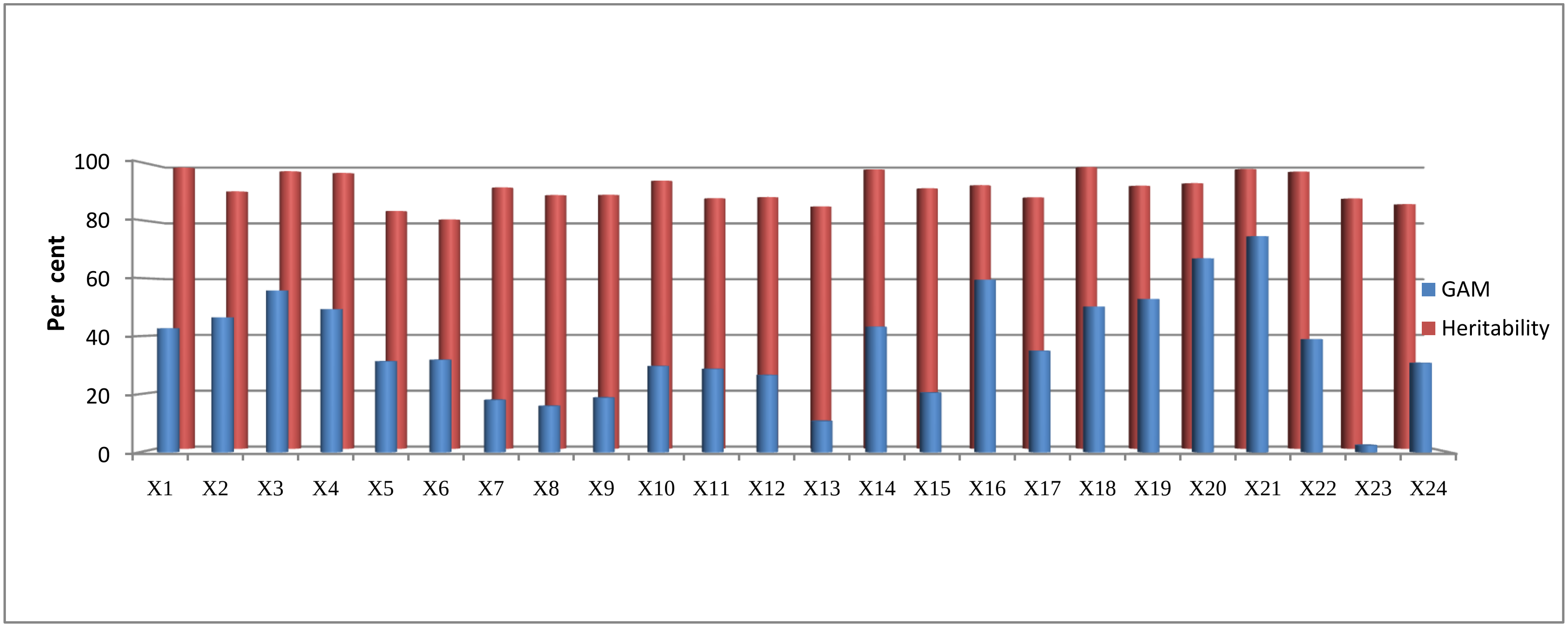

Fig. 4: Heritability and genetic advance as per cent mean for different characters in cucumber

X_1: Vine length
X_2: Number of branches
X_3: Number of nodes
X_4: Internodal length
X_5: Node of first male flower appe
X_6: Node of first female flower appearance
X_7: Days to first male flower anthesis
X_8: Days to first female flower anthesis
X_9: Days to 50% flowering
X_{10}: Male flowers per plant
X_{11}: Female flowers per plant
X_{12}: Sex ratio
X_{13}: Days to first fruit harvest
X_{14}: Fruit length
X_{15}: Fruit diameter
X_{16}: Fruit flesh thickness
X_{17}: Fruit cavity at edible stage
X_{18}: Average fruit weight
X_{19}: Number of fruits per plant
X_{20}: Yield per plant
X_{21}: Number of seeds per fruit
X_{22}: 100 seed weight
X_{23}: Fruit moisture
X_{24}: Shelf life

To understand the extent to which the observed variations are due to genetic factors, overall variability must be partitioned into heritable and non- heritable components with the aid of genetic components such as mean, range, genotypic and phenotypic coefficients of variation, heritability and genetic advance over per cent mean. The results in respect of these characters were estimated and presented in Table 9 and 10.

4.3.1 Vine length (cm)

The vine length has exhibited high variability among the traits studied, which ranged from 115.13 cm to 241.95 cm in Dharwad local and Green salad respectively, with a general mean of 175.70 cm. The phenotypic and genotypic coefficients were 20.89 and 20.80 per cent respectively. The broad sense heritability was found to be high (99.20 %) coupled with high (42.66 %) genetic advance over per cent mean and the genetic advance of 74.96.

4.3.2 Number of branches per plant

The mean number of branches per plant was 4.70 which ranged from 2.50 (CH-20) to 6.90 (Dharwad Local). The GCV and PCV were high with 23.67 % and 24.84 % respectively, with higher broad sense heritability (90.80 %) and GAM (46.45 %) for which the genetic advance was 2.18.

4.3.3 Number of nodes per vine

The mean number of nodes per vine was 25.40 with the maximum number of node (37.00) in NCH-1 and minimum nodes (12.70) in Sambar Sauthe. It has recorded higher PCV (27.63 %) and GCV (27.34 %). The heritability (97.90 %) and genetic advance over per cent mean (55.72 %) were also higher with genetic advance of 14.17.

4.3.4 Internodal length

The distance between two nodes varied significantly among the genotypes studied ranging from 3.76 cm in COHC-37 to 10.95 cm in IIHR-304 with mean length of 7.27 cm. All the genetic components like GCV (24.24 %), PCV (24.58 %), heritability (97.30 %) and GAM (49.26 %) were recorded to be of higher magnitude with genetic advance of 3.58.

4.3.5 Node of first female flower appearance

Nodal position at which the first female flower appeared ranged from 3.50 (IIHR-341) to 6.60 (CH-20) with the mean value of 5.23. It has recorded a genetic advance of 1.67 with moderate PCV (19.10 %), GCV (17.18 %), high heritability (80.90 %) and GAM (31.84 %).

4.3.6 Node of first male flower appearance

The mean of node bearing first male flower was 2.29 which ranged from 1.50 (IIHR-341) to 2.90 (Himangi) with moderate GCV and PCV of 16.35 and 17.85 per cent respectively. High heritability (83.90 %) coupled with high genetic advance over per cent mean (31.31 %) were recorded with genetic advance of 0.70.

4.3.7 Days to first female flower anthesis

The days required for the anthesis of first female flower ranged from 40.3 to 55.40 in Himangi and Green Long respectively, with a mean of 46.83 days. Low PCV and GCV of 8.64 and 8.17 per cent were recorded respectively with high heritability of 89.50 per cent, moderate GAM of 15.92 per cent and genetic advance 7.47.

4.3.8 Days to first male flower anthesis

The days required for the anthesis of first male flower ranged from 32.00 to 45.10 days in Himangi and Green Long respectively, with a mean of 38.72 days. Low PCV and GCV of 9.48 and 9.10 per cent were recorded respectively with high heritability of 92.20 per cent, moderate GAM of 18.00 per cent and genetic advance 6.98.

4.3.9 Days to 50% flowering

Number of days required for 50% flowering ranged from 40.50 to 58.00 in COHC-37 and Sambar Sauthe respectively, with the general mean of 48.02 days. The moderate PCV (10.19 %) and low GCV (9.64 %) with associated high heritability (89.60 %), moderate GAM (18.81 %) and genetic advance 9.10 were recorded.

4.3.10 Number of female flowers per plant

The mean number of female flowers per plant was 27.40 which ranged from 18.40 (Hassan Local) to 35.70 (Poinsette). The phenotypic and genotypic coefficients of variation were moderate with 15.75 and 14.81 per cent respectively. High heritability (88.40 %) coupled with high genetic advance over per cent mean (28.70 %) associated with genetic advance of 7.86.

4.3.11 Number of male flowers per plant

The mean number of male flowers per plant was 148.17 which ranged from 115.40 (Hassan Local) to 221.50 (Green salad). The phenotypic and genotypic coefficients of variation were moderate with 15.21 and 14.80 per cent respectively. The heritability was high (94.60 %) coupled with high genetic advance over per cent mean (29.66 %) associated with genetic advance of 43.97.

4.3.12 Sex ratio

The mean sex ratio was 5.59 male flowers for one female flower which ranged from 4.34 (Poinsette) to 7.25 (Green salad). The phenotypic and genotypic coefficients of variation were moderate with 14.51 and 13.68 per cent respectively. Sex ratio was also recorded high heritability (88.80 %) coupled with high genetic advance over per cent mean (26.56 %) associated with genetic advance of 1.48.

4.3.13 Days to first fruit harvest

The mean number of days taken for first edible fruit harvest was 53.34 days, which ranged from 47.50 days in Hassan Local to 58.30 days in PCUC-6. The phenotypic and genotypic coefficients of variation were lower with 6.09 and 5.63 per cent respectively, with the high broad sense heritability (85.50 %) coupled with moderate genetic advance over per cent mean (10.72 %) associated with genetic advance of 5.72.

4.3.14 Total number of fruits per plant

The number of fruits per plant ranged from 4.60 fruits (IIHR-304 and Sirsi Local) to 10.50 fruits (Hassan Local) with the overall mean value of 6.60 fruits. The PCV and GCV were higher with 27.60 and 26.60 per cent respectively, with the high broad sense heritability (92.80 %) coupled with high genetic advance over per cent mean (52.79 %) associated with genetic advance of 3.48.

4.3.15 Average fruit weight (g)

The average fruit weight was recorded minimum in NCH-1 (130.50 g) and maximum in PCUC-6 (371.93 g) with the mean value of 263.31 g. The recorded phenotypic and genotypic coefficients of variability were higher for this trait with 24.53 and 24.45 per cent respectively. The heritability was recorded high (99.40 %) coupled with high GAM (50.21 %) and the genetic advance of 132.22.

4.3.16 Fruit yield per plant (kg)

Fruit yield was ranged from 1.11 kg in IIHR-304 to 3.58 kg in TMG-1 with the general mean value of 1.95 kg. Different genetic components like GCV (33.48 %), PCV (34.57 %), heritability (93.70 %) and GAM (66.77 %) were recorded to be of higher magnitude with genetic advance of 1.30.

4.3.17 Fruit length (cm)

The minimum fruit length was recorded in NCH-1 (13.80 cm) and maximum fruit length in COHC-42 (29.86 cm) with the overall mean of 22.54 cm. The genetic components *viz.,* GCV (21.29 %), PCV (21.14 %), heritability (98.60 %) and GAM (43.25 %) were recorded to be of high magnitude with genetic advance of 9.75.

4.3.18 Fruit diameter (cm)

The mean diameter of fruit was 5.51 cm which ranged from 4.23 cm in Hassan Local to 7.02 cm in COHC-42. The observed phenotypic and genotypic coefficients of variability were moderate with 10.84 per cent and 10.39 per cent respectively. The higher heritability was recorded (91.90 %) coupled with high GAM (20.52 %) and the genetic advance of 1.13.

4.3.19 Fruit flesh thickness (cm)

The minimum flesh thickness was recorded in CH-20 (1.08 cm) and maximum was in Dharwad Local (3.16 cm) with general mean of 1.68 cm. The estimated genetic components *viz.,* GCV (31.00 %), PCV (29.91 %), heritability (93.00 %) and GAM (59.42 %) were recorded to be of higher magnitude with genetic advance of 1.00.

4.3.20 Fruit cavity at edible stage (cm)

The mean value of fruit cavity was 2.87 cm which was ranged from 1.40 cm to 3.48 cm in IIHR-304 and COHC-42 respectively. The observed phenotypic and genotypic coefficients of variability were moderate with 19.13 per cent and 18.01 per cent respectively. The higher heritability was recorded (88.70 %) coupled with high GAM (34.94 %) and the genetic advance of 1.00.

4.3.21 Number of seeds per fruit

The mean value of number of seeds per fruit was 191.36 seeds which were minimum in IIHR-304 (91.10 seeds) and maximum in White Long (323.80 seeds). All the genetic components estimated like GCV (36.42 %), PCV (36.58 %), heritability (98.70 %) and GAM (74.38 %) were recorded higher magnitude with genetic advance of 142.30.

4.3.22 100 seed weight (g)

The mean value of 100 seed weight was 2.72 g which was ranged from 1.53 g (Himangi) to 3.50 g (EUM-402-102). The phenotypic and genotypic coefficients were moderate with 19.32 per cent and 19.10 per cent respectively. The broad sense heritability was recorded high magnitude of 97.80 per cent coupled with high (38.92 per cent) genetic advance over per cent mean and the genetic advance of 1.06.

4.3.23 Fruit moisture content (%)

The moisture content of the fruit was ranged from 92.97 per cent (COHC-37) to 96.78 per cent (Salad cucumber) with the overall mean of 95.13 per cent. The recorded phenotypic and genotypic coefficients of variability were lowest for this trait with 1.30 per cent and 1.23 per cent respectively. The heritability was recorded high (88.30 %) coupled with low GAM (2.39 %) and the genetic advance of 2.28.

4.3.24 Shelf life (days)

The mean value of fruit shelf life is 6.60 days which was ranged from 4.60 days in IIHR-304 and NCH-1 to 8.10 days in Sambar Sauthe and Dharwad Local. The phenotypic and genotypic coefficients were moderate with 17.30 per cent and 16.07 per cent respectively. The broad sense heritability was recorded high magnitude of 86.30 per cent coupled with high (30.76 per cent) genetic advance over per cent mean and the genetic advance of 2.03.

The comparison of various genetic parameters was presented in Table 11.

4.4 Character association among different parameters

Plant selection is facilitated by the magnitude and nature of the correlations between different traits (Falconer and Mackay, 1996). Plant breeders strive to develop cultivars that perform well for several traits at the same time whenever the correlation between said traits can be irrefutably attributed to genetic and not environmental causes (Ceballos, 1998). It is risky to use phenotypic correlations because they do not clearly reflect the correlation between genetic and environmental causes (Espitia, 2004). When two traits express a high genetic correlation, it is possible to select one by selecting the associated trait (Agrawal, 1998).

The results of genotypic and phenotypic correlation were presented in Table 12 and 13. In general genotypic correlation coefficients were higher than their corresponding phenotypic correlation coefficients for yield per plant.

Table 11: Comparison of various variability parameters for different traits in cucumber genotypes

Character	Coefficient of variation						Heritability (%)			Genetic advance as per cent mean (%)		
	Phenotypic			Genotypic								
	L	M	H	L	M	H	L	M	H	L	M	H
Vine length (cm)	-	-	√	-	-	√	-	-	√	-	-	√
Number of branches per plant	-	-	√	-	-	√	-	-	√	-	-	√
Number of nodes per plant	-	-	√	-	-	√	-	-	√	-	-	√
Internodal length (cm)	-	-	√	-	-	√	-	-	√	-	-	√
Node of first female flower appearance	-	√	-	-	√	-	-	-	√	-	-	√
Node of first male flower appearance	-	√	-	-	√	-		-	√		-	√
Days to first female flower anthesis	√	-	-	√	-	-	-	-	√	-	√	-
Days to first male flower anthesis	√	-	-	√	-	-	-	-	√	-	√	-
Days to 50% flowering	-	√	-	√	-	-	-	-	√	-	√	-
Number of female flowers per plant	-	√	-	-	√	-	-	-	√	-	-	√
Number of male flowers per plant	-	√	-	-	√	-	-	-	√	-	-	√
Sex ratio	-	√	-	-	√	-	-	-	√	-	-	√
Days to first fruit harvest	√	-	-	√	-	-	-	-	√	-	√	-
Fruit length (cm)	-	-	√	-	-	√	-	-	√	-	-	√
Fruit diameter (cm)	-	√		-	√	-	-	-	√	-	-	√
Fruit flesh thickness (cm)	-	-	√	-	-	√	-	-	√	-	-	√
Fruit cavity at edible stage (cm)	-	√		-	√	-	-	-	√	-	-	√
Average fruit weight (g)	-	-	√	-	-	√	-	-	√	-	-	√
Total number of fruits per plant	-	-	√	-	-	√	-	-	√	-	-	√
Yield per plant (kg)	-	-	√	-	-	√	-	-	√	-	-	√
Number of seeds per fruit	-	-	√	-	-	√	-	-	√	-	-	√
100 seed weight (g)	-	√	-	-	√	-	-	-	√	-	-	√
Fruit moisture (%)	√	-	-	√	-	-	-	-	√	√	-	-
Shelf life (days)	-	√	-	-	√	-	-	-	√	-	-	√

GCV, PCV and GAM: 0-10 % = low, 10-20%= Moderate, >20% = High; Heritability: 0-30% = Low, 30-60% = Moderate. >60% = High, √ - Presence, - Absence

Table 12: Genotype correlation coefficients between yield and its attributing traits in cucumber

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	X_{21}	X_{22}	X_{23}
X_1	1	0.120	0.499**	0.097	0.083	0.423**	0.381**	-0.086	0.290*	0.080	0.323*	0.198	-0.129	0.152	-0.416**	-0.290*	-0.088	0.211	-0.038	0.322*	0.295*	-0.148	0.108
X_2		1	-0.374**	0.531**	-0.373**	-0.002	0.100	0.165	0.152	-0.014	0.219	0.218	0.090	0.024	0.492**	0.106	-0.135	-0.145	0.083	-0.194	0.046	0.091	-0.274
X_3			1	-0.784**	0.461**	0.220	0.071	-0.162	0.255	0.089	0.229	0.265	-0.155	0.215	-0.625**	-0.180	-0.102	0.140	-0.070	0.140	0.001	-0.283	0.015
X_4				1	-0.437**	-0.025	0.100	0.115	-0.071	-0.015	-0.049	-0.141	-0.018	-0.234	0.452**	-0.073	-0.022	-0.003	0.015	-0.0007	0.255	0.167	0.038
X_5					1	-0.037	0.006	-0.246	-0.024	-1.333**	0.142	0.198	0.127	0.380**	-0.532**	-0.114	0.216	0.043	0.024	0.167	-0.026	-0.142	0.060
X_6						1	0.881**	0.327*	0.047	-0.167	0.260	0.613**	0.026	0.199	-0.332*	-0.258	-0.162	-0.257	-0.193	0.341*	-0.065	-0.256	-0.283
X_7							1	0.611**	0.100	-0.184	0.326*	0.739**	0.311*	0.386**	-0.076	-0.007	0.136	-0.186	0.050	0.244	0.049	-0.032	-0.153
X_8								1	-0.103	-0.100	-0.072	0.558**	0.134	0.102	0.213	0.015	0.134	-0.341*	0.061	-0.314*	-0.019	0.300*	-0.197
X_9									1	0.620**	0.494**	0.160	0.328*	0.253	0.026	0.317*	0.099	0.005	0.356*	0.248	0.293*	0.073	0.261
X_{10}										1	-0.357*	-0.188	-0.065	0.263	0.060	0.354*	-0.097	-0.042	0.144	-0.203	0.274	0.006	0.112
X_{11}											1	0.389**	0.463**	-0.007	-0.103	-0.031	0.196	0.056	0.409**	0.538**	-0.002	0.071	0.144
X_{12}												1	0.163	0.513**	-0.009	-0.053	0.208	-0.189	0.024	-0.069	0.208	0.125	-0.111
X_{13}													1	0.429**	0.310*	0.417**	0.487**	-0.072	0.451**	0.413**	-0.233	0.353*	0.223
X_{14}														1	0.063	0.412**	0.411**	-0.121	0.031	0.082	0.213	0.133	0.103
X_{15}															1	0.366*	0.347*	-0.010	0.207	-0.306*	0.052	0.400**	0.160
X_{16}																1	0.569**	0.130	0.412**	-0.216	0.038	0.284*	0.364*
X_{17}																	1	0.250	0.648**	-0.168	0.175	0.683**	0.602**
X_{18}																		1	0.206	0.012	0.524**	0.033	0.743**
X_{19}																			1	0.058	0.092	0.589**	0.398**
X_{20}																				1	-0.112	-0.350*	0.110
X_{21}																					1	-0.031	0.482**
X_{22}																						1	0.310*
X_{23}																							1

*, ** Significant at 5% and 1% probability level respectively

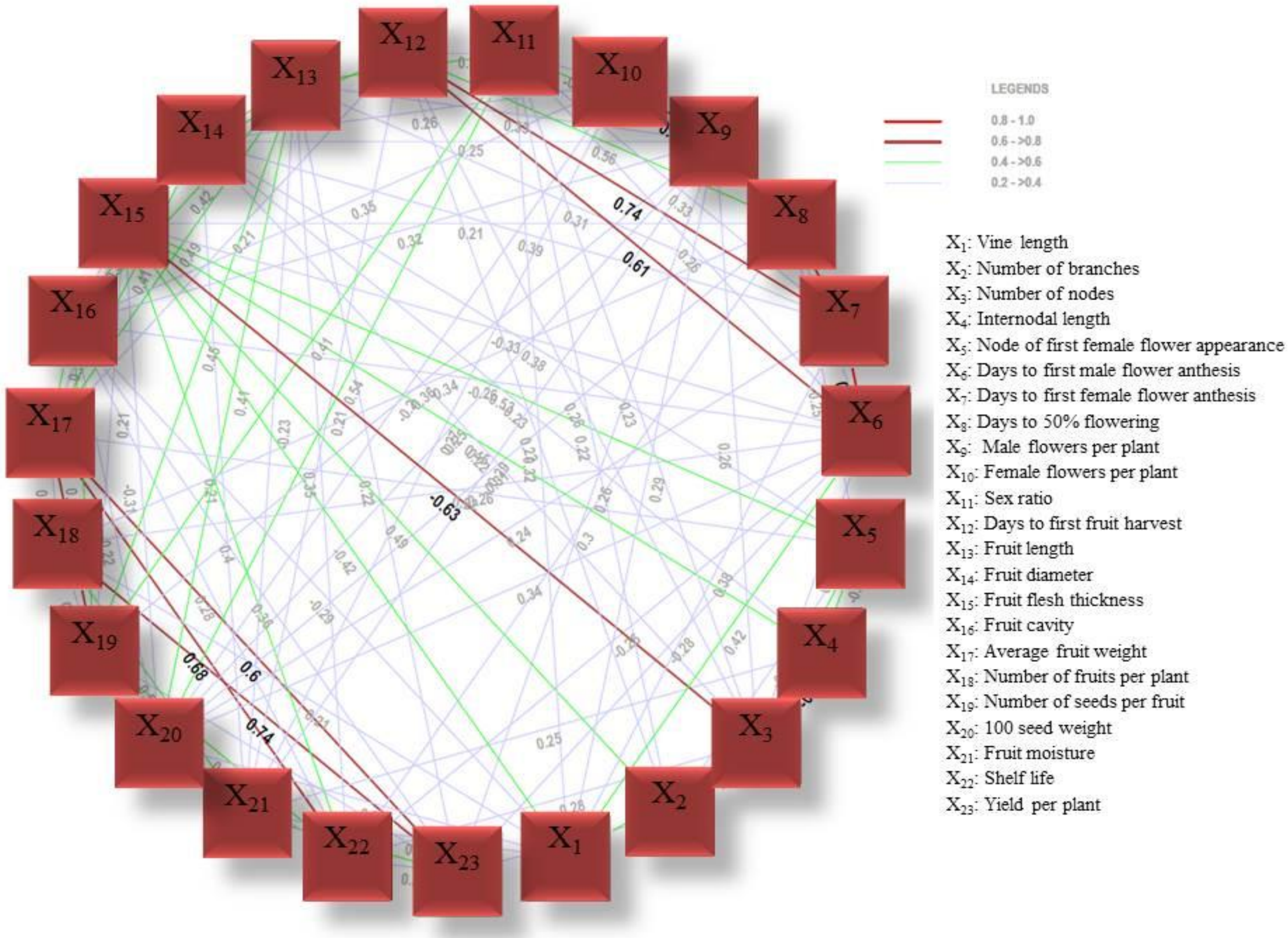

Fig. 5: Genotypic correlation coefficients between fruit yield and its attributing traits in cucumber

Table 13: Phenotypic correlation coefficients between yield and its attributing traits in cucumber

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	X_{21}	X_{22}	X_{23}
X_1	1	0.112	0.493**	0.100	0.079	0.400*	0.364*	-0.089	0.276	0.076	0.301*	0.169	-0.127	0.140	-0.401**	-0.272	-0.087	0.201	-0.035	0.317*	0.272	-0.129	0.099
X_2		1	-0.343*	0.491**	-0.282	-0.012	0.095	0.200	0.174	0.032	0.195	0.178	0.078	-0.013	0.451**	0.037	-0.130	-0.139	0.081	-0.190	0.036	0.110	-0.244
X_3			1	-0.784**	0.427**	0.197	0.082	-0.156	0.249	0.099	0.204	0.235	-0.159	0.188	-0.589**	-0.195	-0.104	0.120	-0.062	0.136	0.010	-0.235	0.012
X_4				1	-0.410**	-0.018	0.073	0.105	-0.076	-0.033	-0.037	-0.144	-0.014	-0.206	0.417**	-0.042	-0.019	0.005	0.010	0.004	0.231	0.140	0.032
X_5					1	0.026	-0.021	-0.190	0.004	-0.059	0.093	0.186	0.108	0.322*	-0.451**	-0.115	0.199	-0.048	0.040	0.118	-0.044	-0.063	0.057
X_6						1	0.838**	0.280	0.027	-0.153	0.205	0.587**	0.020	0.203	-0.312*	-0.208	-0.150	-0.201	-0.194	0.321*	-0.074	-0.288*	-0.244
X_7							1	0.519**	0.104	-0.099	0.238	0.687**	0.290*	0.336*	-0.048	-0.022	0.131	-0.163	0.056	0.215	0.059	-0.025	-0.114
X_8								1	-0.065	-0.085	-0.024	0.497**	0.119	0.088	0.203	-0.015	0.123	-0.306*	0.050	-0.306*	-0.033	0.264	-0.166
X_9									1	0.590**	0.482**	0.158	0.318*	0.201	0.039	0.268	0.097	-0.014	0.346*	0.227	0.277	0.093	0.252
X_{10}										1	-0.393**	-0.134	-0.062	0.216	0.082	0.280	-0.089	-0.031	0.020	-0.197	0.253	0.038	0.129
X_{11}											1	0.309*	0.430**	-0.030	-0.082	-0.041	0.180	0.016	0.384**	0.495**	0.004	0.059	0.112
X_{12}												1	0.155	0.462**	0.008	0.001	0.199	-0.124	0.012	-0.056	0.151	0.080	-0.062
X_{13}													1	0.417**	0.290*	0.402**	0.486**	-0.067	0.442**	0.412**	-0.222	0.329*	0.211
X_{14}														1	0.041	0.409**	0.400***	-0.083	0.026	0.091	0.190	0.085	0.099
X_{15}															1	0.309*	0.330*	-0.012	0.209	-0.300*	0.043	0.355*	0.151
X_{16}																1	0.536**	0.155	0.371**	-0.197	0.027	0.246	0.319*
X_{17}																	1	0.240	0.642**	-0.163	0.165	0630**	0.587**
X_{18}																		1	0.189	0.021	0.449**	-0.003	0.702**
X_{19}																			1	0.057	0.089	0.551**	0.379**
X_{20}																				1	-0.110	-0.330*	0.101
X_{21}																					1	-0.003	0.454**
X_{22}																						1	0.250
X_{23}																							1

*, ** Significant at 5% and 1% probability level respectively

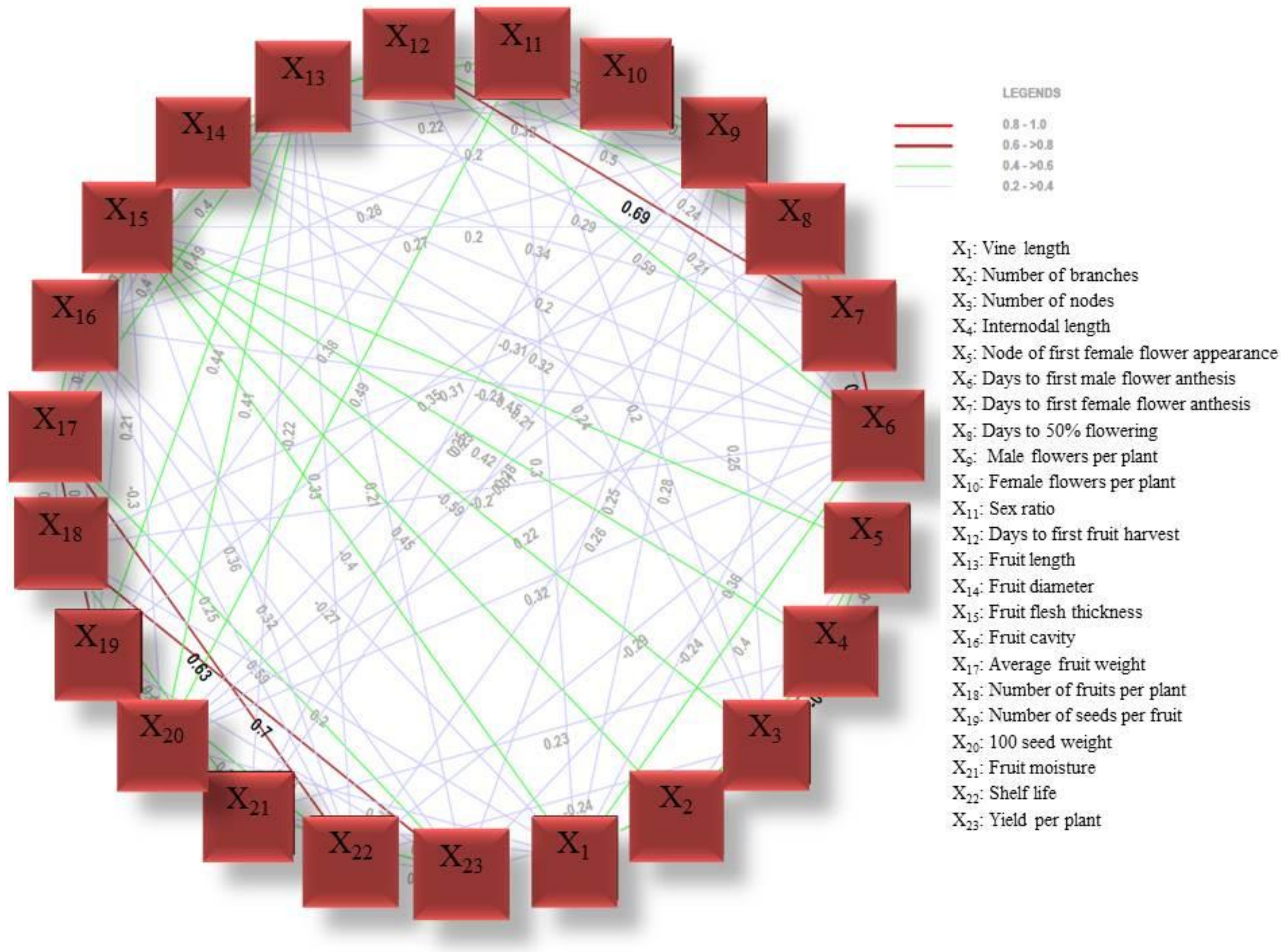

Fig. 6: Phenotypic correlation coefficients for fruit yield and its components

The results of correlation analysis revealed that the number of fruits per plant (0.743) had positive and significant correlation with fruit yield followed by average fruit weight (0.602), fruit moisture (0.482), number of seeds per fruit (0.398) and fruit cavity (0.364) at both genotypic and phenotypic levels indicating strong inherent association. The shelf life (0.310) of fruit showed significant positive correlation with fruit yield at genotypic level.

The number of branches (-0.274), days to first male flower anthesis (-0.283), days to first female flower anthesis (-0.153), days to 50% flowering (-0.197), days to first fruit harvest (-0.111) were non-significant and negatively correlated with fruit yield.

The traits such as vine length (0.108), number of nodes (0.015), internodal length (0.038), node of first female flower appearance (0.060), male flowers per plant (0.261), female flowers per plant (0.112), sex ratio (0.144), fruit length (0.223), fruit diameter (0.103), flesh thickness (0.160) and 100 seed weight (0.110) were non-significant and positively correlated with fruit yield.

4.5 Path coefficient analysis

Correlation studies alone are not indicative of interrelationships among heritable traits and thus this may lead to negative results (Bhatt, 1973). Correlation analysis indicates only the nature and extent of the association between yield and its components, but does not show the direct and indirect effects of different yield attributes on yield *per se*. Yield is dependent on several characters which are mutually associated; these will in turn impair the true association existing between a component and fruit yield. A change in any one component is likely to disturb the whole network of cause and effect. Thus, each component has 2 paths of action *viz.,* the direct influence on fruit yield and the indirect effect through components which are not revealed from the correlation studies. Path coefficient analysis measures the direct and indirect effect and permits the separation of the correlation coefficients into components of direct and indirect effect (Dewey and Lu, 1959). Wright (1921) proposed a method called path analyses which partition the estimated correlation into the direct and indirect effect. Dewey and Lu (1959) first carried out path analyses in plants.

Table 14: Genotypic path coefficient analysis between fruit yield and its attributing traits in cucumber

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	X_{21}	X_{22}	r_g
X_1	**-0.136**	-0.016	-0.068	-0.013	-0.011	-0.057	-0.052	0.012	-0.039	-0.011	-0.044	-0.027	0.017	-0.021	0.057	0.039	0.012	-0.029	0.005	-0.044	-0.040	0.020	0.108
X_2	0.037	**0.308**	-0.115	0.164	-0.114	-0.0008	0.031	0.051	0.047	-0.004	0.068	0.067	0.028	0.007	0.152	0.033	-0.042	-0.045	0.026	-0.060	0.014	0.028	-0.274
X_3	0.091	-0.074	**0.198**	-0.156	0.092	0.044	0.014	-0.032	0.051	0.018	0.045	0.052	-0.031	0.043	-0.124	-0.036	-0.020	0.029	-0.014	0.028	0.0002	-0.056	0.015
X_4	-0.033	-0.183	0.270	**-0.344**	0.150	0.008	-0.034	-0.040	0.024	0.005	0.017	0.049	0.006	0.080	-0.155	0.025	0.008	0.001	-0.005	0.0002	-0.088	-0.057	0.038
X_5	0.039	-0.176	0.217	-0.206	**0.471**	0.018	-0.032	-0.116	-0.011	-0.063	0.067	0.093	0.060	0.179	-0.251	-0.054	0.102	-0.020	0.011	0.079	-0.012	-0.067	0.060
X_6	0.408	-0.003	0.212	-0.024	0.036	**0.964**	0.849	0.315	0.046	-0.161	0.251	0.591	0.025	0.192	-0.320	-0.249	-0.156	-0.248	-0.187	0.329	-0.063	-0.247	-0.283
X_7	-0.439	-0.115	-0.082	-0.113	0.077	-1.014	**-1.151**	-0.703	-0.115	0.212	-0.375	-0.850	-0.359	-0.445	0.087	0.008	-0.156	0.215	-0.057	-0.281	-0.056	0.037	-0.153
X_8	-0.088	0.168	-0.167	0.118	-0.253	0.335	0.627	**1.025**	-0.105	-0.103	-0.074	0.572	0.137	0.105	0.218	0.015	0.137	-0.350	0.063	-0.322	-0.019	0.307	-0.197
X_9	-0.515	-0.270	-0.456	0.127	0.043	-0.084	-0.178	0.183	**-1.781**	-1.104	-0.879	-0.284	-0.584	-0.450	-0.045	-0.565	-0.178	-0.008	-0.634	-0.442	-0.522	-0.131	0.261
X_{10}	0.150	-0.027	0.166	-0.029	-0.250	-0.313	-0.346	-0.188	1.163	**1.876**	-0.670	-0.353	-0.123	0.493	0.113	0.664	-0.182	-0.080	0.027	-0.382	0.514	0.012	0.112
X_{11}	0.501	0.340	0.355	-0.076	0.220	0.404	0.506	-0.112	0.766	-0.554	**1.551**	0.603	0.718	-0.011	-0.160	-0.048	0.304	0.087	0.635	0.834	-0.003	0.110	0.144
X_{12}	-0.090	-0.099	-0.121	0.064	-0.090	-0.280	-0.337	-0.255	-0.073	0.086	-0.177	**-0.456**	-0.074	-0.234	0.004	0.024	-0.095	0.086	-0.011	0.032	-0.095	-0.057	-0.111
X_{13}	0.049	-0.034	0.059	0.006	-0.048	-0.010	-0.118	-0.051	-0.124	0.025	-0.176	-0.062	**-0.380**	-0.163	-0.118	-0.158	-0.185	0.027	-0.171	-0.157	0.088	-0.134	0.223
X_{14}	-0.066	-0.010	-0.094	0.102	-0.165	-0.087	-0.168	-0.044	-0.110	-0.114	0.003	-0.223	-0.187	**-0.435**	-0.027	-0.179	-0.180	0.053	-0.013	-0.036	-0.096	-0.058	0.103
X_{15}	-0.232	0.275	-0.349	0.252	-0.297	-0.185	-0.042	0.119	0.014	0.034	-0.058	-0.005	0.173	0.035	**0.558**	0.204	0.194	-0.006	0.116	-0.171	0.029	0.223	0.160
X_{16}	-0.136	0.050	-0.084	-0.034	-0.053	-0.121	-0.003	0.007	0.148	0.165	-0.015	-0.025	0.195	0.193	0.171	**0.468**	0.266	0.061	0.193	-0.101	0.018	0.133	0.364*
X_{17}	-0.072	-0.110	-0.083	-0.018	0.176	-0.132	0.111	0.109	0.0814	-0.079	0.160	0.170	0.397	0.335	0.283	0.464	**0.815**	0.204	0.528	-0.137	0.143	0.557	0.602**
X_{18}	0.119	-0.082	0.079	-0.002	-0.024	-0.145	-0.105	-0.192	0.003	-0.024	0.032	-0.106	-0.041	-0.068	-0.006	0.073	0.141	**0.564**	0.116	0.007	0.296	0.020	0.743**
X_{19}	0.024	-0.053	0.045	-0.010	-0.015	0.124	-0.032	-0.040	-0.228	-0.009	-0.262	-0.015	-0.289	-0.020	-0.133	-0.264	-0.416	-0.132	**0.641**	-0.037	-0.059	-0.378	0.398**
X_{20}	0.390	-0.234	0.169	-0.0009	0.202	0.411	0.295	-0.379	0.299	-0.245	0.649	-0.084	0.498	0.098	-0.369	-0.261	-0.203	0.014	0.070	**1.206**	-0.135	-0.422	0.110
X_{21}	0.172	0.027	0.0007	0.148	-0.015	-0.038	0.029	-0.011	0.171	0.159	-0.001	0.121	-0.136	0.124	0.030	0.022	0.102	0.305	0.054	-0.065	**0.582**	-0.018	0.482**
X_{22}	-0.0723	0.044	-0.138	0.081	-0.069	-0.125	-0.016	0.146	0.036	0.003	0.034	0.061	0.172	0.065	0.195	0.138	0.333	0.016	0.287	-0.171	-0.015	**0.488**	0.310*

*, ** Significant at 5% and 1% probability level respectively

Residual effect=0.107

Bolded figures on diagonal are direct effects

The result of genotypic path analysis was presented in table 14. The results of path analysis revealed high direct effect of average fruit weight (0.815), number of seeds per fruit (0.641), fruit moisture (0.582), number of fruits per plant (0.564), shelf life (0.488) and fruit cavity (0.364) were significant positive correlation coefficients and registered high direct effect with on fruit yield. Whereas the number of branches per plant (0.308), days to first male flower anthesis (0.964) and sex ratio (1.025) were registered high direct effects on yield but were non-significant and negatively correlated with the fruit yield.

The number of nodes (0.198), node of first female flower appearance (0.471), female flowers per plant (1.876), sex ratio (1.551), flesh thickness (0.558) and 100 seed weight (1.206) were recorded high direct effects but are non-significant and positively correlated with fruit yield. The residual effect of genotypic path coefficient analysis is 0.107.

4.6 Downy mildew incidence

The twenty four cucumber genotypes were subjected for downy mildew disease reaction under field condition. Disease was started 49 days after planting. The PDI was ranged from 9.82% (Dharwad Local) to 51.59% (CH-20). Out of 24 genotypes, Dharwad Local was resistant, four genotypes including check Poinsette (22.90%) were moderately resistant whereas eighteen genotypes were moderately susceptible and CH-20 was susceptible to downy mildew. The result of scoring for downy mildew disease is presented in Table 15.

Table 15: Screening of cucumber genotypes for downy mildew disease under field condition

Sl. No.	Genotype	PDI (%)
1.	TMG-1	33.12
2.	Hassan Local	37.71
3.	EUM-402-102	34.82
4.	Mullu Sauthe	31.35
5	Sambar Sauthe	13.43
6.	White Long	24.85
7.	COHC-37	28.39
8.	Green Long	27.77
9.	CH-1	31.18
10.	SWL	26.30
11.	Green Salad	29.55
12.	Poinsette	22.90
13.	Himangi	34.74
14.	Salad cucumber	49.50
15.	KC-1	43.91
16.	CH-20	51.59
17.	PCUC-6	29.13
18.	COHC-42	32.98
19.	NCH-1	27.86
20.	Dharwad Local	9.82
21.	IIHR-304	22.55
22.	KH-1	28.46
23.	IIHR-341	26.03
24.	Sirsi Local	27.44
	SEm±	1.39
	CD at 5%	4.24
	CV (%)	6.74

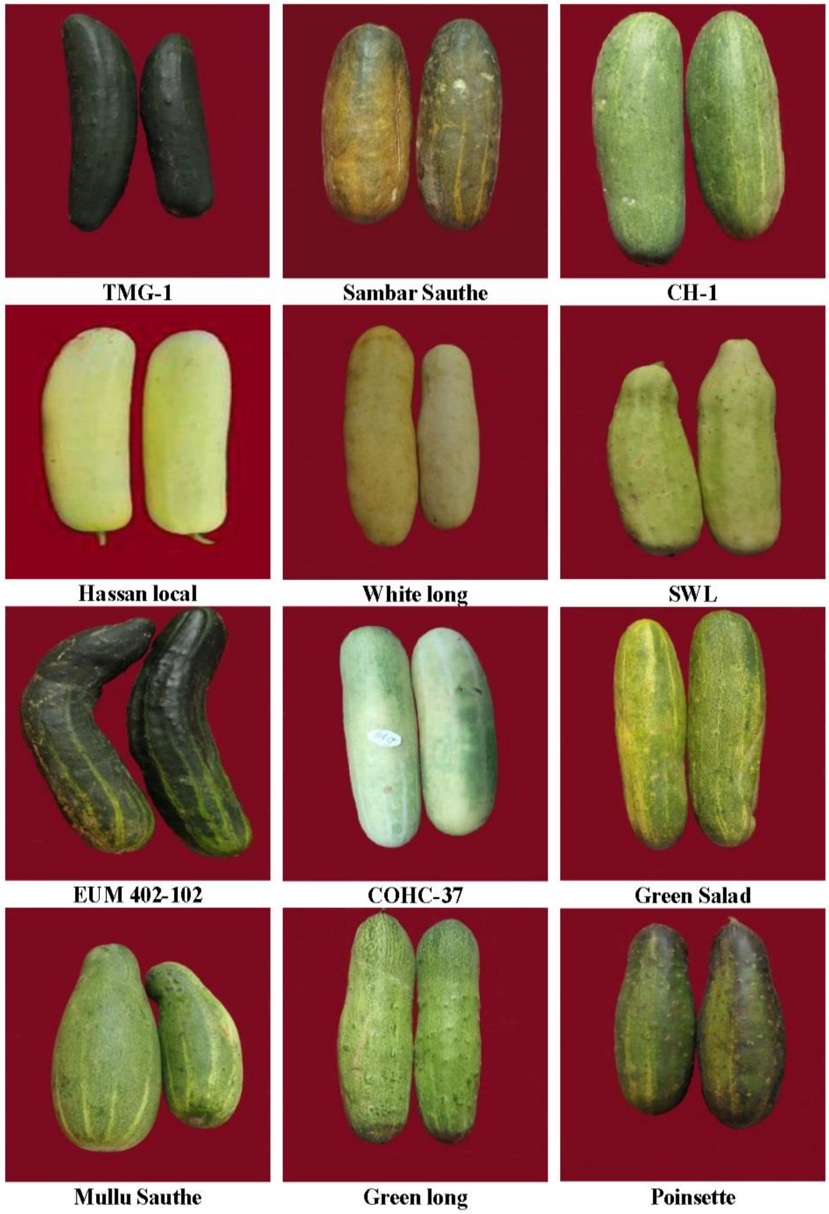

Plate 2: Variability in fruit morphology of twenty four cucumber genotypes

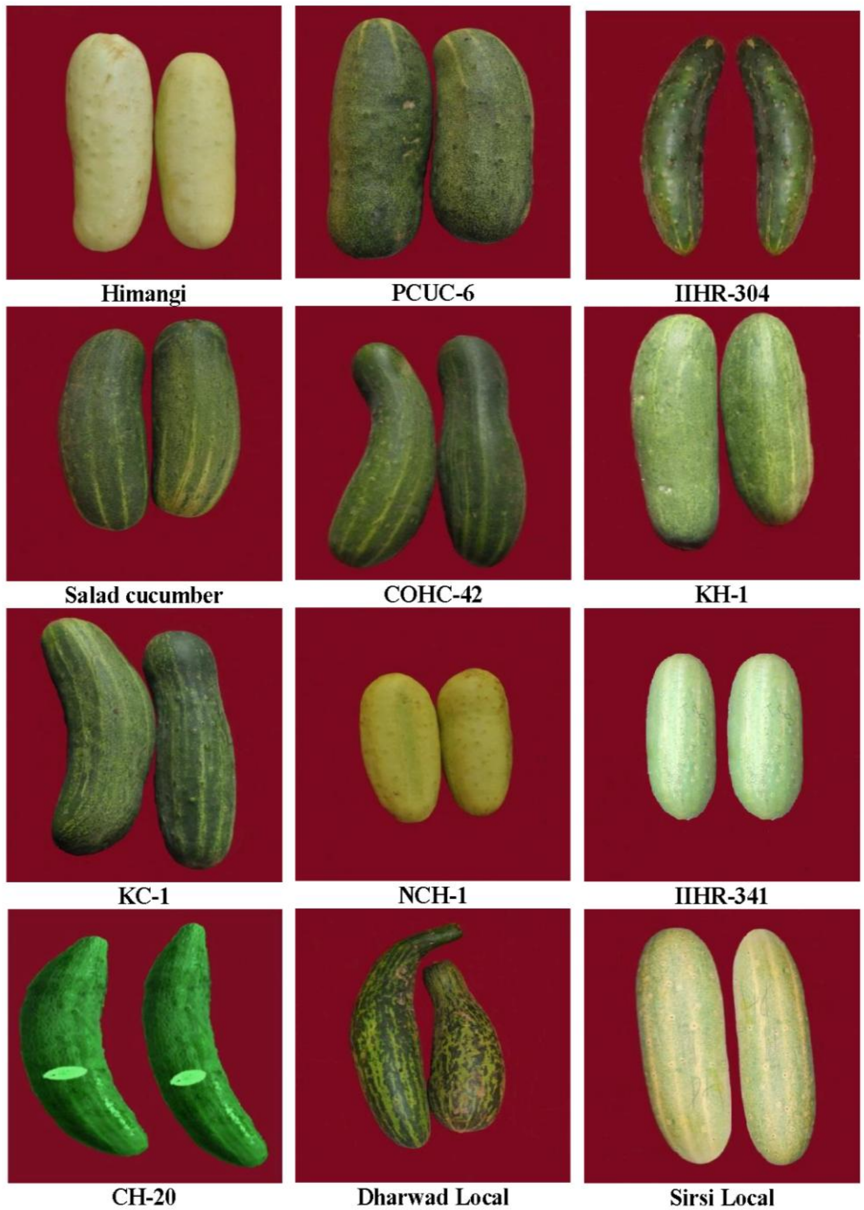

Plate 2: Variability in fruit morphology of twenty four cucumber genotypes

V. DISCUSSION

Plant breeders are very much concerned over integrating many desirable traits in one genotype, either by positive or negative selection which favours the expression of desirable trait. As fruit yield is a complex character that is determined by complex associations among several agronomic traits (Chandra *et al*., 1990; Rao *et al*., 1990), the first step for achieving genetic improvement in yield is understanding the genetic parameters *via* variability, heritability pattern, genetic advance achievable and correlation among characters. An effective breeding programme aimed at improving fruit yield of a crop requires information on the nature and magnitude of variability. Thus, the assessment of the magnitude of variability present in the crop would help in the successful utilization of the crop characters in developing suitable cultivars for yield and yield stability (Singh *et al*., 1985). Therefore, to plan an efficient breeding program, it is necessary to have information about its genetic and heritability pattern, information on character association, their direct and indirect effects.

There is not much information on genetic variability for yield and quality components in cucumber. Hence the present investigation focused on variability, genetic advance, correlation, path analysis and per cent disease incidence of downy mildew in 24 cucumber genotypes for different characters. The result obtained is discussed under the following headings.

5.1 Performance of genotypes

5.2 Variability

5.3 Heritability and genetic advance

5.4 Character association among different parameters

5.5 Path coefficient analysis

5.6 Downy mildew incidence

5.1 Performance of genotypes

Mean performance of genotypes is the essential component of any statistical evaluation utilized in estimation of various genetic components like variances, coefficients of variation, heritability and genetic advance. The analysis of variance for different quantitative characters revealed that mean squares were highly significant for all the characters indicating enough variability in genotypes. Similar results were obtained by Afangideh and Uyoh (2007) and Gaikwad *et al*. (2011) in cucumber; Choudhary *et al.* (2011) and Pandey *et al*. (2005), Tomar *et al.*(2008) in muskmelon; Rahman *et al*. (2002) in snake gourd; Basumatary *et al.* (2014) in spine gourd; Dubey *et al.* (2013) in ridge gourd; Munshi *et al.* (2007) in *Cucumis sativus var. hardwickii* ; Islam *et al.* (2009) in bitter gourd; Khan *et al.* (2009) in pointed gourd; Kumar *et al.* (2011b) in bottle gourd.

5.2 Variability

Genetic variability is a pre-requisite for a successful breeding program of any crop species and a critical survey of genetic variability is essential before initiating an improvement program aiming to develop high yielding varieties (Haussmann *et al.*, 2004).

The higher degree of variation was observed in phenotypic and genotypic variance among the characters studied. A close proximity in the phenotypic and genotypic coefficients of variability was observed indicating a little influence of environment in the expression of various traits studied.

5.2.1 Variability for growth parameters

High genotypic and phenotypic coefficients of variation were recorded for vine length, number of branches per plant, number of nodes per plant, internodal length suggesting that the variation was due to genotype and there was very little influence of environment on the expression of character and there is scope for phenotypic selection of these traits. Similar results were obtained by Singh *et al.*

(2014) for Branches per plant, plant height; Basumatary *et al*. (2014) and Khan *et al*. (2009) for number of primary branches, node of first female flower appearance, fruit length, number of primary branches; Veena *et al.* (2012) for node at which first female flower appears, node of first male flower appearance, Days to first male flower opening; Fayeun *et al*. (2012) recorded high PCV for internodal length of fluted pumpkin.

Moderate genotypic and phenotypic coefficients of variation were recorded for few traits such as node of first male flower appearance, node of first female flower appearance, number of female flowers per plant, number of male flowers per plant and sex ratio. The results are in accordance with the findings of Yadav *et al*. (2009) for node of first male flower appearance and node of first female flower appearance and contrary to the findings of Arunkumar *et al.* (2011) for number of female flowers per plant, number of male flowers per plant and Rakhi and Rajamony (2005) findings where sex ratio has reported high coefficients of variation.

Low genotypic and phenotypic coefficients of variation were recorded for days to first female flower anthesis, days to first male flower anthesis, days to first fruit harvest indicating more influence of environment on expression of traits and less scope for phenotypic selection of these traits. The results are in agreement with Veena *et al.* (2012) and Arunkumar *et al.* (2011) for days to first female flower opening and days to first fruit harvest; Yadav *et al*. (2009) for days to first male flower anthesis, days to first fruit harvest; Rahman *et al.* (2002), Rakhi and Rajamony (2005), Pandey *et al.* (2005) and Choudhary *et al.* (2011) for days to first female flower anthesis, days to first male flower anthesis; Singh and Lal (2005) and Gaikwad *et al.* (2011) for days to first fruit harvest.

Days to 50% flowering has recorded moderate PCV and low GCV in accordance with Aruah *et al*. (2011) and Rana and Pandit (2011).

5.2.2 Variability for yield parameters

High genotypic and phenotypic coefficients of variation was recorded for fruit length, fruit flesh thickness, average fruit weight, number of fruits per plant, yield per plant and number of seeds per fruit. The results are in confirmation with Veena *et al.* (2012); Gaikwad *et al.* (2011) for fruit length, average fruit weight and number of fruits per plant; Munshi *et al.* (2007) for average fruit weight, number of fruits per plant and yield per plant.

Moderate genotypic and phenotypic coefficients of variation were recorded for fruit diameter, fruit cavity and 100 seed weight. Similar results were reported by Yadav *et al*. (2009); Arunkumar *et al.* (2011) for fruit diameter; Kumar *et al*. (2009) for fruit cavity.

5.2.3 Variability for quality parameters

Moderate genotypic and phenotypic coefficients of variation were recorded for shelf life which is in contrary with the high coefficients of variation by Rakhi and Rajamony (2005). Low genotypic and phenotypic coefficients of variation were recorded for fruit moisture per cent. Similar results were documented by Mehta *et al*. (2009) in muskmelon.

5.3 Heritability and genetic advance

The heritability was high for all the traits studied indicating less influence of environment in the expression of these traits. Heritability estimated with genetic advance will be of more accurate judging the genetic control and expression of the character.

5.3.1 Heritability and genetic advance for growth parameters

The higher estimates of heritability coupled with higher genetic advance as per cent mean was obtained for all the growth characters studied except days to first female flower anthesis, days to first male flower anthesis, days to fifty per cent flowering and days to first fruit harvest indicating that all these characters were controlled by additive gene action, less influenced by environmental factors and scope for improvement of these traits through selection. High heritability for all these characters has been reported by Gaikwad *et al*. (2011) and Uddin *et al*. (2006) in cucumber. Yadav *et al.* (2009) and Veena *et al.* (2012) reported high heritability coupled with high genetic advance as per cent mean for number of nodes per plant, node of first male flower appearance and number of branches per plant in cucumber. Uddin *et al.* (2006) reported similar results for vine length, node of first female flower appearance, female flowers per plant, number of fruits per plant, yield per plant, fruit length.

High heritability coupled with moderate genetic advance as per cent mean was registered for days to first female flower anthesis, days to first male flower anthesis, days to 50 per cent flowering and days to first fruit harvest indicating the action of both additive and non-additive gene action. Similar results were reported for days to first female flower anthesis (Kumar *et al*., 2008 ; Uddin *et al*., 2006; Singh and Lal, 2005), days to first male flower anthesis (Kumar *et al*., 2008 ; Kumar *et al*., 2009; Singh and Lal, 2005; Arunkumar *et al*., 2011), high heritability for days to 50% flowering (Afangideh and Uyoh, 2007; Pandey *et al*., 2005; Aruah *et al*., 2011), days to first fruit harvest (Kumar *et al*., 2009) were also recorded. The present results are contrary to the report of Veena *et al.* (2012) where days to first female flower anthesis and days to first male flower anthesis recorded high heritability coupled and high genetic advance as per cent mean. High heritability was reported for days to 50% flowering (Afangideh and Uyoh, 2007; Pandey *et al*., 2005; Aruah *et al*., 2011), sex ratio in culinary melon (Rakhi and Rajamony, 2005).

5.3.2 Heritability and genetic advance for yield parameters

The higher estimates of heritability coupled with higher genetic advance as per cent mean was obtained for all yield characters studied suggesting that all these characters were controlled by additive gene action and good scope for improvement by imposing selection. Yadav *et al.* (2009) and Veena *et al.* (2012) reported high heritability coupled with high genetic advance as per cent mean for number of fruits per plant, fruit length, fruit diameter, fruit cavity at edible stage, average fruit weight, 100 seed weight, fruit yield per plant in cucumber. Uddin *et al.* (2006) reported similar results for number of fruits per plant, yield per plant and fruit length.

5.3.3 Heritability and genetic advance for quality parameters

High heritability associated with low genetic advance as per cent mean was noticed for fruit moisture per cent suggesting more influence of environment which is in agreement with the findings of Mehta *et al*. (2009) in muskmelon.

5.4 Character association among different parameters

Knowledge of the nature of association between yield and its components is of great necessary in any breeding programme. The extent and direction of association are measured by correlation coefficients. Correlation studies provide information that selecting one character will result in progress for all positively correlated characters. Many of the characters are correlated because of mutual association, positive or negative, with other characters.

Yield is product of interaction between the yield components. Grafius (1959) suggested that there may not be genes for yield *per se*. Rather there could be genes which govern the inheritance of component characters and there is no separate gene system for yield *per se*. Griffing (1956) has suggested the possibility of working with yield components which are likely to be more simply inherited than by itself. The contribution of the components of yield is through the component compensation mechanism (Adams, 1967). Since then instead of direct selection on yield, it was practiced for characters making up strong associations with yield.

In general genotypic correlations were higher than their corresponding phenotypes suggesting strong inherent association between the traits at genotypic level (Srivastva and Srivastva, 1976; Singh *et al*., 1977; Indresh, 1982; Lawande and Patil, 1989; Panthi *et al.*, 1995; Bharathi *et al.*, 2005; Singh *et al.*, 2009; Rahman *et al.*, 2011; Singh *et al.*, 2013) for yield per plant.

The correlation analysis revealed that the number of fruits per plant had positive and significant correlation with fruit yield followed by average fruit weight, fruit moisture, number of seeds per fruit and fruit cavity at genotypic levels indicating strong inherent association. As fruit yield is a polygenic trait, it is difficult to follow direct selection. Therefore, selection for these highly associated traits will indirectly aid in selecting genotypes with high yield. Hence it is worthwhile to plan selection strategies based on breeding objective. Similar results were reported for number of fruits per plant, fruit weight in cucumber (Arunkumar *et al.,* 2011) spine gourd (Aliya *et al*., 2014); seeds per fruit in bitter gourd (Singh *et al*., 2014); number of fruits per plant in cucumber (Afangideh and Uyoh, 2007), snake gourd (Rahman *et al*., 2002) and summer squash (Marie and Mohammed, 2010); average fruit weight in Summer squash (Marie and Mohammed, 2010). Rahman *et al.* (2002) reported negative correlation for number of seeds per fruit with yield.

The number of branches, days to first male flower anthesis, days to first female flower anthesis, days to 50 per cent flowering, days to first fruit harvest were non-significant and negatively correlated with fruit yield. Similar results were reported for number of branches (Islam *et al.,* 2009), days to first male flower anthesis and days to first male flower anthesis (Rahman *et al.,* 2002; Bhave *et al.,* 2003; Dey *et al.,* 2005; Suchitra and Haribabu, 2006; Dubey *et al.,* 2013), days to 50 per cent flowering (Afangideh and Uyoh, 2007; Basumatary *et al*., 2014; Rana and Pandit, 2011), days to first fruit harvest (Kumar *et al*., 2008; Hossain *et al*., 2010; Rana and Pandit, 2011; Dubey *et al.,* 2013).

Some of the traits such as vine length, number of nodes, internodal length, node of first female flower appearance, male flowers per plant, female flowers per plant, sex ratio, fruit length, fruit diameter, flesh thickness and 100 seed weight were positively correlated with fruit yield but are non-significant suggesting the selection for different characters simultaneously and independently.

5.5 Path coefficient analysis

Correlation studies alone are not indicative of interrelationships among heritable traits and thus this may lead to negative results (Bhatt, 1973). Correlation analysis indicates only the nature and extent of the association between yield and its components, but does not show the direct and indirect effects of different yield attributes on yield *per se*. Fruit yield is dependent on several characters which are mutually associated; these will in turn impair the true association existing between a component and fruit yield. A change in any one component is likely to disturb the whole network of association. Thus, each component has 2 paths of action *viz.,* the direct influence on fruit yield and the indirect effect through components which are not revealed from the correlation studies. Path coefficient analysis measures the direct and indirect effect and permits the separation of the correlation coefficients into components of direct and indirect effect (Dewey and Lu, 1959).

Results of path analysis revealed that the number of fruits per plant is an important component of fruit yield at genotypic level as it has relatively high and positive direct effect. Other traits such as average fruit weight, fruit cavity, number of seeds per fruit, fruit moisture and shelf life were also registered high direct effect on fruit yield. Hence, selection for these traits results in improvement of fruit yield depending on objective of crop improvement. Similar results were documented by Resmi and Sreelathakumary (2012) and Rashid *et al.* (2014).

The number of branches per plant, days to first male flower anthesis and days to 50 per cent flowering were registered high direct effects but non-significant and negatively correlated with the fruit yield indicating the need for simultaneous selection model to nullify the undesirable indirect effects in order to make use of the direct effect. Similar results were reported by Singh *et al.* (2012) for days to 50 per cent flowering in bottle gourd.

The Vine length number of nodes, node of first female flower appearance, female flowers per plant, sex ratio, flesh thickness and 100 seed weight were recorded high direct effects but are non-significant and positively correlated with fruit yield. Hence, selection can be practiced simultaneously and independently for different traits. The results are in consonance with the findings of Suchitra and Haribabu (2006); Resmi and Sreelathakumary (2012).

The residual effect is 0.107 indicating the characters considered for path analysis are sufficient to explain 89.3 per cent of variation in the population.

5.6 Downy mildew incidence

Downy mildew is one of the serious foliar diseases in cultivation of cucumber. It is caused by *Pseudoperonospora cubensis* Rostow. and only countable numbers of resistant varieties are available. Disease management is one most important strategy in successful cultivation need to emphasize through integrated management. One best method among them is host plant resistant through resistant sources.

In the present study, Dharwad Local (resistant) was recorded lowest PDI whereas highest was recorded in CH-20 (susceptible). Sambar Sauthe, White Long, IIHR-304 and Poinsette were registered moderately resistant disease reaction whereas 18 genotypes (TMG-1, Hassan Local, EUM-402-102, Mullu Sauthe, COHC-37, Green Long, CH-1, SWL, Green salad, Himangi, Salad cucumber, KC-1, PCUC-6, COHC-42, NCH-1, KH-1, IIHR-341 and Sirsi Local) registered moderately susceptible reaction to downy mildew.

VI. SUMMARY

Cucumber (*Cucumis sativus* L.) is an important warm season vegetable crop with versatile uses such as salad ingredient, pickles, desert fruit, cooked vegetable, refreshing condiment and it has got cooling, soothing, cleansing and softening properties which make it possible to have extensive use in cosmetics industry. Very less attention has been paid for its improvement in India. Improvement in any crop depends upon the extent of variability present in the basic genetic material. Again the breeding objective varies with local market preferences, especially in cucumber. The present study was undertaken to assess the information on the nature of variability, heritability and association of component characters with yield and quality parameters in cucumber genotypes. The genetic variability existing in a population was assessed using parameters like genotypic and phenotypic coefficients of variation, heritability, genetic advance over per cent mean. Estimation of PDI for downy mildew incidence was carried out to record the disease reaction. The correlation and path coefficient analysis were carried out to know the character association among different growth, yield and quality attributes and to partition their direct and indirect effects on yield respectively. Downy mildew is one of the serious foliar diseases in cultivation of cucurbits due wider distribution of pathogen. Only few commercial cucumber varieties resistant to downy mildew disease available in India are becoming susceptible to downy mildew making it necessary to find out resistance source.

The present study was carried out during the growing season of 2014-15 at College of Horticulture, UHS campus, GKVK, Bengaluru using 24 diverse cucumber genotypes. The experiment was laid out in a Randomized Block Design (RBD) with two replications. Separate blocks were maintained for variability studies and downy mildew incidence evaluation. All the cultural practices were carried out as per the recommendations of package of practices, University of Horticultural Sciences, Bagalkot (Anon., 2013b).

Observations were recorded on five randomly selected representative plants on different traits *viz.,* growth characters like vine length, number of branches, number of nodes, internodal length, node of first male flower appearance, node of first female flower appearance, days to first female flower anthesis, days to first male flower anthesis, days to 50 per cent flowering, female flowers per plant, male flowers per plant, sex ratio, days to first fruit harvest, fruit characters like number of fruits per plant, yield per plant, fruit length, fruit diameter, fruit flesh thickness, fruit cavity at edible stage, number of seeds per fruit, 100 seed weight, fruit moisture per cent, shelf life of fruit and pulp texture.

Analysis of variance for individual character was done on the basis of mean values as suggested by Panse and Sukhatme (1967). The components of variances, heritability and genetic advance were estimated as per the method suggested by Burton and Devane (1953), Falconer (1981) and Johnson *et al.* (1955) respectively. Downy mildew was visually assessed using linear 0 to 5 scale (Girisha, 1989) and the Per cent Disease Index (PDI) was calculated using the formula suggested by McKinney (1923).

The analysis of variance revealed wide range of variability existed in 24 cucumber genotypes for the traits studied. The phenotypic and genotypic coefficients were higher for vine length, number of branches, number of nodes, fruit length, flesh thickness, fruit cavity, average fruit weight, fruits per plant, yield per plant, number of seeds per fruit indicating strong genetic control and scope for yield improvement through selection of these traits.

The high heritability coupled with high genetic advance as per cent mean were observed for all the traits except for days to first female flower anthesis, first female flower anthesis, days to 50 per cent flowering, days to first fruit harvest and fruit moisture per cent indicating the additive gene action controlling these characters and scope for improvement by selection.

The correlation coefficients were partitioned into phenotypic and genotypic coefficients, where the genotypic correlation coefficients were higher than phenotypic coefficients indicating the inherent relationship among the characters studied. Cucumber yield was significant and positively correlated with number of fruits per plant followed by average fruit weight, fruit moisture per cent, number of seeds per fruit and fruit cavity at both phenotypic and genotypic levels confirming strong inherent association of these traits with yield. Further, path analysis was carried out to partition the direct and indirect effects of these traits on fruit yield. The results showed high direct effects of number of fruits per plant, average fruit weight, fruit moisture per cent, number of seeds per fruit and fruit cavity on fruit yield of cucumber emphasizing the worthiness of incorporation of these traits in improving fruit yield.

The performance of 24 cucumber genotypes under field conditions for downy mildew revealed that the genotype Dharwad Local as resistant and CH-20 as susceptible. Four genotypes *viz.,* Sambar Sauthe, White Long, IIHR-304 and Poinsette were found moderately resistant and remaining eighteen genotypes were of moderately susceptible with varying Per cent Disease Index (PDI).

Future line of work

1. The genotypes showing high fruit yield and number of fruits could be utilized in breeding programme as these two traits are significantly correlated and also high direct effect.

2. The number of fruits per plant, average fruit weight and fruit cavity recorded high heritability and genetic advance as per cent mean along with significant positive correlation and high direct effect on fruit yield. Hence, these characters should be given due importance for further improvement in fruit yield.

3. Further studies on variability at molecular level will also account for crop improvement.

4. Screening of cucumber genotypes to other important diseases and pests helps in identifying resistant sources for gene introgression

VII. REFERENCES

*ADAMS, M.W., 1967, Plant architecture and yield breeding. *Iowa State J. Res.,* **56**: 225-254.

AFANGIDEH, U. AND UYOH, E.A., 2007, Genetic variability and correlation studies in some varieties of cucumber (*Cucumis sativus* L.). *Jordan J. Agric. Sci.,* **3**(4): 376-384.

*AGRAWAL, R.L., 1998, Fundamentals of plant breeding and hybrid seed production. Science Publisher, New Hampshire. pp: 394.

AHMED, M., HAMID, A. AND AKBAR, Z., 2004, Growth and yield performance of six cucumber (*Cucumis sativus* L.) cultivars under agro climatic conditions of Rawalakot, Azad Jammu and Kashmir. *Int. J. Agric. Biol.,* **6**(2): 396-399.

AHSAN, F.N., ISLAM, A.K.M.A., RASUL, M.G., MIAN, M.A.K. AND HOSSAIN, M.M., 2014, Genetic variability in snake gourd (*Tricosanthes cucurminata*). *J. Agric. Technol.,* **10**(2): 355-366.

AKTER, S., RASUL, M.G., ISLAM, A.K.M.A. AND HOSSAIN, M.M., 2013, Genetic variability, correlation and path coefficient analysis of yield and quality traits in pumpkin (*Cucurbita moschata* Duch Ex Poir.). *Bangladesh J. Pl. Breed. Genet*., **26**(1): 25-33.

ALIYA, F., BEGUM, H., REDDY, M.T., SIVARAJ, N., PANDRAVADA, S.R. AND NARSHIMULU, G., 2014, Correlation and path coefficient analysis of quantitative characters in spine gourd (*Momordica dioica* Roxb.). *Pak. J. Biol. Sci*., **17**(5): 659-666.

*AL-JIBOURI, H.A., MILLAR, P.A. AND ROBINSON, H.V., 1958, Genotypic and environmental variances and co-variances in an upland cotton cross of interspecific origin. *Agron. J*., **50**: 533-536.

ANONYMOUS, 2013a, Crop wise statistics of Horticultural crops in Karnataka state 2011-12, Government of Karnataka, Directorate of Horticulture, Department of Horticulture, Lalbagh, Bangalore, pp: 52.

ANONYMOUS, 2013b, Package of practices for integrated Horticulture (Kannada). *Univ. Hort. Sci.,* Bagalkot (India), pp: 93-97.

ANONYMOUS, 2014, Indian Horticulture Database-2013, area and production of fruits and vegetables-all India (2013-14), Ministry of Agriculture, Government of India.

ARUAH, B.C., UGURU, M.I. AND OYIGA, B.C., 2011, Genetic variability and inter- relationship among some Nigerian pumpkin accessions (*Cucurbita* spp.). *Int. J. Pl. Breed*., **6**(1): 34-41.

ARUMKUMAR, K.H., PATIL, M.G., HANCHINAMANI, C.N., GOUD, I.S. AND HIREMATH, S.V., 2011, Genetic relationship of growth and development traits with fruit yield in F_2 population of BGDL × Hot season of cucumber (*Cucumis sativus* L.). *Karnataka J. Agric. Sci*., **24**(4): 497-500.

*AUGUSTIN, M.A., OSMAN, A., AZUDIN, M.N. AND MOHAMED, S., 1988, Physico-chemical changes in muskmelon *(Cucumis melo* L.) during Storage. *Pertanika*, **11**(2): 203-209.

BASUMATARY, P., BORA, G.C., KALITA, U.C., SAIKIA, L. AND DEKA, N.C., 2014, Variability and correlation studies in spine gourd (*Momordica dioica* Roxb.). *Direct Res. J. Agric. Food Sci.*, **2**(7): 77-81.

BHARATHI, L.K., NAIK. G., SINGH, H.S. AND DORA, D.K., 2005, Correlation and path analysis in spine gourd (*Momordica diocia* Roxb.). *Orissa J. Hort*., **33**: 105-108.

*BHATT, G.M., 1973, Significance of path coefficient analysis in determining the nature of character association. *Euphytica*, **22**: 338-343.

BHAVE, S.G., MEHTA, J.L., BENDALE, V.W., MHATRE, P.P. AND PETHE, U.B., 2003, Character association and path coefficient analysis of bitter gourd (*Momordica charantia* L.). *Orissa J. Hort*., **31**(1): 44-46.

BRAR, P.S., SINGH, G., SINGH, M. AND BATTH, G.S., 2011, Genetic analysis for quality traits and reaction to downy mildew in cucumber (*Cucumis sativus* L.). *J. Res. Punjab Agric. Univ*., **48** (1&2): 28-33.

*BURTON, G.W. AND DEWANE, E.V.M., 1953, Estimating heritability in tall fescue (*Festuca arundianacea* L.) from replicated clonal material. *Agron. J*., **45**: 478-481.

*CEBALLOS, L.H., 1998, Quantitative genetics. Univ. Columbia, Palmira. pp: 524.

*CHANDRA, A., VERMA, B.K. AND SHARMA, R.K., 1990, Evaluation of related chilli lines. *Veg. Sci*., **7**: 47-48.

CHOUDHARY, H., RAM, H.H. AND SINGH, D. K., 2011, Genetic variability studies in muskmelon. *Prog. Hort*., **43**(2): 231-233.

CRAMER, C.S. AND WEHNER, T.C., 2000, Path analysis of the correlation between fruit number and plant traits of cucumber populations. *Hort. Sci*., **35**(4): 708–711.

DEWAN, M.M.R., MONDAL, S., ISLAM, M.S., MUKUL, M.H.R. AND HOSSEN, M.A., 2014, Study on correlation and path analysis of the yield contributing characters of different ash gourd accessions. *Eco-friendly Agric. J.*, **7**(1): 01-05.

*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.

DEY, S.S., BEHERA, T. K., PAL, A. AND MUNSHI, A. D., 2005, Correlation and path coefficient analysis in bitter gourd (*Momordica charantia* L.). *Veg. Sci.,* **32**(2): 173-176.

DHARMATTI, P.R., PATIL, R.V., PATIL, S.S. AND ATHANI, S.I., 2008, A new coccinia (*Coccinia indica*) DRC-1, a variety boon to vegetable growers. *Karnataka J. Agric. Sci.,* **21**(1): 99-103.

DHIMAN, J. S., TARSEM, L. AND BAJAJ, K. L., 1995, Evaluation of muskmelon (*Cucumis melo* L.) genotypes for multiple disease resistance, yield and quality characteristics. *Trop. Agric*., **72**: 58-62.

DUBEY, R.K., SINGH, V. AND UPADHYAY, G., 2013, Genetic variability and inter-relationship among some ridge gourd *(Luffa acutangula* L.*)* accessions under foot hills of Arunachal Pradesh. *Prog. Hort*., **45**(1): 192-197.

ESPITIA, C.M., 2004. Estimation of genetic parameters of *Cucurbita moschata* Dusch. Ex. Poir. *Doctorate thesis*, Univ. Columbia, Palmira. pp: 206.

*ESQUINAS, A.J.T. AND GULICK, P.J., 1983, Genetic resources of cucurbitaceae. International board for plant genetic resources, Rome.

*FALCONER, D.S., 1960, Introduction to quantitative genetics. First edition, London Longman Group Ltd. Longman house, Harrow, England, pp: 321.

FALCONER, D.S., 1981, Introduction to quantitative genetics. Second edition, London Longman Group Ltd., Longman house, Harrow, England, pp: 350.

FALCONER, D.S. AND MACKAY, T.F., 1996, Introduction to quantitative genetics. Fourth edition. Preintice Hall, London. pp: 480.

FAYEUN, L. S., ODIYI, A.C., MAKINDE, S.C.O. AND AIYELARI, O.P., 2012, Genetic variability and correlation studies in the fluted pumpkin (*Telfairia occidentalis* Hook F.). *J. Pl. Breed. Crop Sci*., **4**(10): 156-160.

GAIKWAD, A.G., MUSMADE, A.M., DHUMAL, S.S. AND SONAWANE, H.G., 2011, Variability studies in cucumber (*Cucumis sativus* L.). *Eco. Env. Cons*., **17**(4): 799-802.

GIRISHA, K. N., 1989, Studies on biological control of powdery mildew pathogens with *Cladosporium* spp., *M.Sc. (Agri.) Thesis*, Univ. Agric. Sci. Bangalore.

GOLABADI, M., GOLKAR, P. AND EGHTEDARY, A.R., 2012, Assessment of genetic variation in cucumber (*Cucumis sativus* L.) genotypes. *European J. Exp. Bio*., **2**(3): 826-830.

GOSWAMI, S., THIND, T.S., RAHEJA, S. AND VASHISHT, V.K., 2011, Screening of muskmelon lines against downy mildew caused by *Pseudoperonospora cubensis* under field condition. *Indian Phytopathol*., **64**(4): 374-375.

*GRAFIUS, J.E., 1959, Heterosis in barley. *Agron. J*., **51**: 551-554.

GRIFFING, B., 1956, Concept of general and specific combining ability in relation to diallel crossing system. *Australian J. Biol. Sci*., **9**: 463-493.

GRISALES, S.O., RESTREPO, M.P.V., CABRERA, F.A.V. AND GARCIA, D.B., 2015, Genetic correlations and path analysis in butternut squash (*Cucurbita moschata* Duch.). *Rev. Fac. Nal. Agric. Medellin*, **68**(1): 7399-7409.

HARIKA, M., GASTI, V.D., SHANTAPPA, T., MULGE, R., SHIROL, A.M., MASTIHOLI, A.B. AND KULKARNI, M.S., 2012, Evaluation of bottle gourd genotypes [*Lagenaria siceraria* (Mol.) Standl.] for various horticultural characters. *Karnataka J. Agric. Sci*., **25**(2): 241-244.

HAUSBECK, M.K. AND CORTRIGHT, B.D**.,** 2009, Evaluation of fungicides for control of downy mildew of pickling cucumber. *Pl. Dis. Management*, **3**: 112-115.

HAUSSMANN, B.I.G., PARZIES, H. K., PRESTERL, T., SUSIC, Z. AND MIEDANER, T., 2004, Plant genetic resources in crop improvement. *Pl. Genet. Resources*, **2**(1): 3-21.

HOLMES, G.J. AND THOMAS, C.E., 2006, The history and re-emergence of cucurbit downy mildew. *Phytopathol.*, **99**: 171.

HOSSAIN, M.F., RABBANI, M.G., HAKIM, M.A., AMANULLAH, A.S.M. AND AHSANULLAH, A.S.M., 2010, Study on variability character association and yield performance of cucumber (*Cucumis sativus* L.). *Bangladesh Res. Publications J*., **4**(3): 297-311.

IBRAHIM, E.A., 2012, Variability, heritability and genetic advance in Egyptian sweet melon (*Cucumis melo var. ezyptiacus* L.) under water stress condition. *Int. J. Pl. Breed. Genet*., **6**(4): 238-244.

*INDRESH, B. T., 1982, Studies on genotypic and phenotypic variability in bitter gourd. *Thesis abstract*. Univ. Agric. Sci., Bangalore. **8**(1): 52.

ISLAM, M.R., HOSSAIN, M.S., BHUIYAN, M.S.R., HUSNA, A. AND SYED, M.A., 2009, Genetic variability and path coefficient analysis of bitter gourd (*Momordica charantia* L.). *Int. J. Sustainable Agric*., **1**(3): 53-57.

*JOHNSON, H.W., ROBINSON, H.F. AND COMSTOCK, R.E., 1955, Estimation of genetic and environmental variability in soybean. *Agron. J*., **47**: 477-483.

KAGADI, S. R., PAWAR, D. R., GADRE, U. A. AND MANDOKHOT, A. M., 2001, Varietal evaluation in ridge gourd against downy mildew. *J. Maharashtra Agric. Univ*., **26**(2): 193-195.

KANTHARAJA, N. M., 2003, Studies on heterosis and combining ability in ridge gourd (*Luffa acutangula* L.). *M.Sc. (Hort.) Thesis,* Univ. of Agric. Sci., Dharwad.

KASHIF, W., KAMRAN, Q.M. AND JILANI, M.S., 2008, Effect of different nitrogen levels on growth and yield of cucumber (*Cucumis sativus* L.). *J. Agric. Res*., **46**(3): 259-266.

KHAN, A. S. M. M. R., KABIR, M. Y. AND ALAM, M. M., 2009, Variability, correlation path analysis of yield and yield components of pointed gourd. *J. Agric. Rural Dev*., **7**(1&2): 93-98.

KHAN, Z., SHAH, A.H., GUL, R., MAJID, A., KHAN, U. AND AHMAD, H., 2015, Morpho-agronomic characterization of cucumber germplasm for yield and yield associated traits. *Int. J. Agron. Agric. Res*., **6**(1): 1-6.

KOCH, P.S. AND COSTA, C.P.D.A., 1991, Inheritance of plant and fruit characters in gherkin. *Hort. Brasilera*, **9**(2): 73-77.

KOZIK, E.U., KLOSINSKA, U.K., CALL, A.D. AND WEHNER, T.C., 2013, Heritability and genetic variance estimates for resistance to downy mildew in cucumber accession Ames 2354. *Crop Sci*., **53**: 177-182.

KUMAR, S. AND SINGH, S.P., 1998, Correlation and path coefficient analysis for certain metric traits in bottle gourd [*Lagenaria siceraria* (Mol.) Stand L.]. *Veg. Sci*., **25**(1): 40-42.

KUMAR, A., KUMAR, S. AND PAL, A.K., 2008, Genetic variability and characters association for fruit yield and yield traits in cucumber. *Indian J. Hort*., **65**(4): 423-428.

KUMAR, S., YADAV, Y.C., BISEN, B. AND DIXIT, S.K., 2009, Genetic variability, heritability and genetic advance for some traits in cucumber (*Cucumis sativus* L.). *Veg. Sci*., **36**(2): 220-221.

KUMAR, K.H.A., RAMANJINAPPA, V. AND PATIL, M.G., 2011a, Genetic variability studies in F_2 population of cucumber (*Cucumis sativus* L.). *Pl. Arch*., **11**(1): 347-350.

KUMAR, A., SINGH, B., KUMAR, M. AND NARESH, R.K., 2011b, Genetic variability, heritability and genetic advance for yield and its components in bottle gourd (*Lagenaria siceraria* M.), *Ann. Hort*., **4**(1): 101-103.

KUMAR, R., AMETA, K.D., DUBEY, R.B. AND PAREEK, S., 2013a, Genetic variability, correlation and path analysis in sponge gourd (*Luffa cylindrica* Roem.). *African J. Biotech*., **12**(6): 539-543.

KUMAR, S., KUMAR, D., KUMAR, R., THAKUR, K.S. AND DOGRA, B.S., 2013b, Estimation of genetic variability and divergence for fruit yield and quality traits in cucumber (*Cucumis Sativus* L.) in North-Western Himalayas. *Universal J. Pl. Sci*., **1**(2): 27-36.

*LAWANDE, K.E. AND PATIL, A.V., 1989, Correlation studies in bitter gourd (*Momordica charantia* L.). *J. Maharashtra Agric. Univ*., **14**(1): 77-79.

*LEBEDA, A., 1991, Resistance in muskmelon to czechoslovak isolates of *Pseudoperanospora cubensis* from cucumber. *Scientia Hortic*., **45**(3-4): 255-260.

LEBEDA, A. AND URBAN, J., 2007, Temporal changes in pathogenicity and fungicide resistance in *Pseudoperonospora cubensis* populations. *Acta Hort*., **731**: 327-336.

LENKA, D. AND MISHRA, B., 1973, Path coefficient analysis of yield in rice varieties. *Indian J. Agric. Sci.,* **43**: 376-379.

MARIE, A.J.I. AND MOHAMMED, G.H., 2010, Correlation, path coefficients and regression analysis in summer squash. *Mesopotomia J. Agric*., **38**(1): (ISSN 1815 – 316X; Supplement 1).

*MCKINNEY, H. H., 1923, A new system of grading plant diseases. *J. Agric. Res.*, **26**: 195-218.

MEHTA, R., SINGH, D. AND BHALALA, M.K., 2009, Genetic variability, heritability and genetic advance in muskmelon (*Cucumis melo* L.). *Veg. Sci.*, **36**(2): 248-250.

MLADENOVIC, E., BERENJI, J., OGNJANOV, V., LJUBOJEVIC, M. AND CUKANOVIC, J., 2012, Genetic variability of bottle gourd [*Lagenaria siceraria* (Mol.) Stand.] and its morphological characterization by multivariate analysis. *Arch. Biol. Sci*., **64**(2): 573-583.

MUNSHI, A.D., PANDA, B., BEHERA, T.K. AND KUMAR, R., 2007, Genetic variability in *Cucumis sativus var. hardwickii* R. (Alef.) germplasm. *Cucurbit genetics cooperative report*, **30**: 5-10.

NAIK, A., AKHTAR, S., CHATTOPADHYAY, A. AND HAZRA, P., 2012, Study of genetic variability, heritability and genetic advance for fruit quality characters in teasel gourd (*Momordica subangulata* Blume. subsp. *renigera*). *African J. Agric. Res*., **7**(49): 6550-6552.

NASRABADI, H.N., NEMATI, H., SOBHANI, A. AND SHARIFI, M., 2012, Study on morphologic variation of different Iranian melon cultivars (*Cucumis melo* L.). *African J. Agric. Res*., **7**(18): 2764-2769.

NIKHIL, G. AND HOSSAIN, M., 2007, Correlation and path analysis in bottle gourd [*Lagenaria siceraria* (Mol.) Stand.]. *Environ. Ecol*., **25**(1): 193-195.

OGBONNA, P.E. AND OBI, I.U., 2010, Variability of yield and yield components in egusi melon. *African Crop Sci. J*., **18**(3): 107-113.

*PALTI, J. AND COHEN, Y., 1980, Downy mildew of cucurbits (*Pseudoperonospora cubensis):* The fungus and its hosts, distribution, epidemiology and control. *Phytopara*., **8**: 109-147.

PANDEY, S., RAI, M. AND SINGH, B., 2005, Genetic variability and character association in muskmelon *(Cucumis melo* L.). *Indian J. Pl. Genet. Resources,* **18**(2): 212-216.

PANDEY, K.K., SINGH, B., GUPTA, R.C., RAI, A.B. AND RAI, M., 2008, Evaluation of cucumber *(Cucumis sativus* L.*)* genotypes against downy mildew. *Veg. Sci.,* **35**(2): 197-198.

PANSE, V.G. AND SUKHATME, P.V., 1967, Statistical methods for agricultural workers. Indian Council of Agricultural Research, New Delhi, pp: 21.

PANTHI, G. H., MISHRA, N. AND MISHRA, R. S., 1995, Correlation and path coefficient studies in bitter gourd. *Indian J. Hort*., **52**(2): 132-136.

PATIL, P.R., SURVE, V.H. AND MEHTA, H.D., 2012, Line x Tester analysis in Rice (*Oryza sativa* L.). *Madras Agric. J*., **99**: 210-213.

PITCHAIMUTHU, M., SOURAVI, K., GANESHAN, G., KUMAR, G.S. AND PUSHPALATHA, R., 2012, Identification of sources of resistance to powdery and downy mildew disease in cucumber (*Cucumis sativus* L.). *Pest Management in Hort. Ecosystems*, **18**(1): 105-107.

PRASANNA, S.C., KRISHNAPPA, K.S. AND REDDY, N.S., 2002, Correlation and path coefficient analysis studies in ridge gourd. *Cur. Res*., **31**(9-10): 150-152.

RAHMAN, M.A., HOSSAIN, M.D., ISLAM, M.S., BISWAS, D.K. AND AHIDUZZAMAN, 2002, Genetic variability, heritability and path analysis in snake gourd (*Trichosanthes anguina* L.). *Pakistan J. Biol. Sci*., **5**(3): 284-286.

RAHAMAN, M.L., CHAKRABORTY AND ACHARYA, P., 2011, Studies on genetic variability and divergence in sweet gourd (*Momordica subangulata spp. renigera* W.) accessions collected from West Bengal. *Indian J. Pl. Genet. Resources*, **24**: 67-73.

RAI, N., YADAV, R.K. AND YADAV, D.S., 2005, Genetic variability studies in chow-chow (*Sechium edule* W.). *Veg. Sci*., **32**(2): 184-186.

RAJA, S., BAGLE, B.G. AND DHANDAR, D.G., 2006, Identification of yield attributes in bottle gourd for rain fed conditions. *Veg. Sci*., **33**(1): 106-108.

RAKHI, R. AND RAJAMONY, L., 2005, Variability, heritability and genetic advance in landraces of culinary melon (*Cucumis melo* L.). *J. Trop. Agric*., **43**(1-2): 79-82.

RAM, D., SINGH, R.S., PANDEY, S. AND RAI, M., 2005, Study of polygenic traits in off season bottle gourd [*Lagenaria siceraria* (Mol.) Stand L.]. *Veg. Sci*., **32**(2): 189-191.

RANA, N.P. AND PANDIT, M.K., 2011, Studies on genetic variability, character association and path analysis in snake gourd *(Trichosanthes anguina* L.) genotypes. *J. Crop Weed,* **7**(2): 91-96.

*RAO, D.S.R.M., SINGH, H., SINGH, B., KHOLA, O.P.S., FARODA, A.S., 1990, Correlation and path coefficient analysis of seed yield and its components in sesame. *Haryana Agric. Univ. J. Res*., **20**: 273-276.

RAO, B.N., RAO, P.V. AND REDDY, B.M.M. 2000. Correlation and path analysis in the segregating population of ridge gourd (*Luffa acutangula* (Roxb.) L.). *Crop Res.,* **20(2)**: 338-342.

RASHID, M.M.U., HAQUE, M.M., MONIRUZZAMAN, M. AND JAMAL, M.A.H.M., 2014, Characterizations and correlation coefficient analysis of snake gourd (*Trichasanthes anguina* L.), *J. Res. Agric. Animal Sci*., **9**(2): 01-06.

*ROBINSON, R.W., 1987, Cold tolerance in cucurbitaceae. *Cucurbits genetics cooperative report.*, **10**: 104.

ROBINSON, R.W. AND DECKER-WALTER, D.S., 1999, *Cucurbits*. Cab International, University Press, Cambridge

REDDY, B.P.K., BEGUM, H., SUNIL, N., REDDY, M.T., BABU, J.D. AND REDDY, R.S.K., 2013, Correlation and path coefficient analysis in muskmelon (*Cucumis melo* L.). *Suranaree J. Sci. Tech.*, **20**(2):135-149.

RESMI, J. AND SREELATHAKUMARY, I., 2012, Character association and path coefficient studies in ash gourd [*Benincasa hispida* (Thunb.) Congn.]. *Agric. Sci. Digest*, **32**(3): 251-255.

SAHNI, G.P., SINGH, R.K. AND SAHA, B.C., 1985, Correlation and path analysis in ridge gourd (*Luffa Acutangula* Roxb.). *Prog. Hort*., **17**: 193-196.

SHARMA, A. AND SENGUPTA, S.K., 2013, Genetic diversity, heritability and morphological characterization in bottle gourd (*Lagenaria siceraria* (Mol.) Stand). *The Bioscan*, **8**(4): 1461-1465.

*SHIVASUBRAMANIAN, S. AND MENON, N., 1973, Heterosis and inbreeding depression in rice. *Madras Agric. J.,* **60**: 1134-1144.

SINGH, H. N., SRIVASTAV, J. P. AND PRASAD, R, 1977, Genetic variability and correlation studies in bitter gourd. *Indian J. Agric. Sci*., **47**: 406-407.

SINGH, R.R., MISHRA, G.M. AND JHA, R.N., 1985, Studies on variability and scope for improvement in pointed gourd. *South Indian Hort.,* **33**(4): 257-260.

SINGH, G. AND LAL, T., 2005, Genetic variability, heritability and genetic advance for yield and its contributing traits in muskmelon *(Cucumis melo* L.). *J. Res. Punjab Agric. Univ*., **42**(2): 168-174.

SINGH, D., BAHADUR, V., SINGH, D.B. AND GHOSH, G., 2009, Spine gourd (*Momordica diocia* Roxb.): an underutilized vegetable with high nutritional and medicinal values. *Acta Hort*., **809**: 241-248.

SINGH, S.K., SINGH, A. AND GANGWAR, L.K., 2011, Variability and heritability studies in cucumber. *Prog. Agric*., **11**(1): 166-167.

SINGH, A.K., PAN, R.S. AND BHAVANA, P., 2012, Correlation and path coefficient analysis for quantitative traits in early season bottle gourd (*Lagenaria siceraria* (Mol.) Standl.). *Veg. Sci*., **39**(2): 198-200.

SINGH, A. K., PAN, R. S. AND BHAVANA, P., 2013, Heterosis and combining ability analysis in bitter gourd (*Momordica charantia* L.). *The Bioscan*, **8**(4): 1533-1536.

SINGH, M.K., BHARDWAJ, D.R. AND UPADHYAY, D.K., 2014, Genetic architecture and association analysis in bitter gourd (*Momordica charantia* L.) landraces. *The Bioscan*, **9**(2): 707-711.

*SRIVASTAVA, V. K. AND SRIVASTAVA, L. C., 1976, Genetic parameter correlation coefficient and path coefficient analysis in bitter gourd (*Momordica charantia* L.). *Indian J. Hort*., **33**: 66-70.

SUCHITRA, V. AND HARIBABU, K., 2006, Correlation studies and path coefficient analysis in bottle gourd [*Lagenaria siceraria* (Mol.) Stand L.]. *The Allahabad Farmer*, **111**(1): 67-73.

SUNDARAM, V., 2010, Studies on character association in bitter gourd (*Momordica charantia* L.) under salt stress. *Asian J. Hort*., **5**(1): 99-102.

TATILIOGLEE, T., 1993, Cucumber (*Cucumis sativus* L.). Genetic improvement of Indian Vegetable crops. Kalloo, G. and Bergh, B.O. (eds.). Pergamon Press, Oxford, pp: 197-233.

TOMAR, R.S. AND BHALALA, M.K., 2006, Combining ability studies in muskmelon (*Cucumis melo* L.). *J. Hort. Sci*., **1**(2): 109-115.

TOMAR, R.S., KULKARNI, G.U., KAKADE, D.K., PATEL, A.D. AND ACHARYA, R.R., 2008, Genetic variability, correlation and path analysis in muskmelon (*Cucumis melo* L.). *The Asian J. Hort*., **3**(1): 158-161.

TORKADI, S.S., MUSMADE, A.M. AND MANGAVE, K.K., 2007, Genetic variability studies in muskmelon (*Cucumis melo* L.). *J. Soils Crops*, **17**(2): 308-311.

UDDIN, G., AHMED, N., NARAYAN, R., NAZIR, G. AND HUSSAIN, K., 2006, Variability studies in cucumber. *Haryana J. Hort. Sci*., **35**(3&4): 297-298.

ULLAH, M.Z., HASAN, M.J., CHOWDHURY, A. Z. M. K. A., SAKI, A. I. AND RAHMAN, A. H. M. A., 2012, Genetic variability and correlation in exotic cucumber (*Cucumis sativus* L.) varieties. *Bangladesh J. Pl. Breed. Genet*., **25**(1): 17-23.

VARALAKSHMI, B., RAO, P.V. AND REDDY, Y.N., 1995, Genetic variability and heritability in ridge gourd (*Luffa acutangula*). *Indian J. Agric. Sci.,* **65**(8): 608-610.

VEENA, R., SIDHU, A.S., PITCHAIMUTHU, M. AND SOURAVI, K, 2012, Genetic evaluation of cucumber (*Cucumis sativus* L.) genotypes for some yield and related traits. *Electronic J. Pl. Breed*., **3**(3): 945-948.

VIJAYKUMAR, 2007, Studies on genetic variability and molecular characterization of bitter gourd (*Momordica charantia* L.) genotypes. *M. Sc. (Hort.) Thesis,* Univ. Agric. Sci., Bangalore.

VISHWANATHA, P. D., 2003, Genetic variability and heterosis studies in muskmelon (*Cucumis melo* L.). *M. Sc. (Hort.) Thesis,* Univ. Agric. Sci., Dharwad.

WARIS, M., ULHAQ, B., KHAN, B.A., AHMAD, C., IQBAL, B., SHOAIB, B. AND ULLAH, D., 2014, Screening of cucumber varieties against downy mildew (*Pseudoperonospora cubensis*) and its chemical management. *Pakistan J. Phytopathol*., **26**: 21-24.

WEHNER, T.C., SHETTY, N.V. AND WILSON, G., 2000, Screening the cucumber germplasm collection for fruit storage ability. *Hort. Sci*., **35**(4): 699-707.

WONDIMU, T., ALAMEREW, S., AYANA, A. AND GAREDEW, W., 2014, Variability and association of quantitative traits in anchote [*Coccinea abyssinica* (Lam.) Cong.] in Ethiopia. *Int. J. Pl. Breed. Genet.*, **8**(1): 1-12.

*WRIGHT, S., 1921, Correlation and causation, *J. Agric. Res*., **20**: 557-587.

YADAV, Y.C., KUMAR, S., BISEN, B. AND DIXIT, S.K., 2009, Genetic variability, heritability and genetic advance for some traits in cucumber. *Indian J. Hort.,* **66**(4): 488-491.

YADAV, Y.C., KUMAR, S. AND SINGH, R., 2012, Studies on genetic variability, heritability and genetic advance in cucumber (*Cucumis sativus* L.). *Hort. Flora Res. Spectrum*, **1**(1): 34-37.

* Original reference not seen

APPENDIX I

The mean monthly meteorological data collected from July 2014-March 2015 (during crop growth period)

Month	Temperature (ºC)		Total Rainfall (mm)	Relative Humidity (per cent)	
	Maximum	Minimum		I h	II h
July 2014	28.3	19.7	80.8	93	54
August 2014	28.2	19.5	117.4	93	56
September 2014	28.5	19.4	128.6	91	54
October 2014	28.1	18.8	428.4	94	56
November 2014	26.9	16.3	29.4	90	54
December 2014	26.6	16.2	1.0	90	48
January 2015	27.4	15.2	10.0	91	45
February 2015	29.9	15.3	0.0	86	42
March 2015	32.2	18.9	21.2	85	37

APPENDIX II

Categorization of genotypes based on days to 50 per cent flowering

Category	Genotype(s)
Early (40 days)	-
Medium (40-55 days)	TMG-1, Hassan Local, EUM-402-102, Mullu Sauthe, White Long, COHC-37, CH-1, SWL, Green Salad, Poinsette, Salad cucumber, KC-1, CH-20 , PCUC-6, COHC-42, NCH-1, Dharwad Local, IIHR-304, KH-1, IIHR-341, Sirsi Local, Himangi
Late (>55 days)	Sambar Sauthe, Green Long,

APPENDIX III

Categorization of genotypes based on fruit length

Category	Genotype(s)
Short (<15 cm)	NCH-1
Medium (15-25 cm)	TMG-1, Hassan Local, Mullu Sauthe, Sambar Sauthe, White Long, COHC-37, SWL, Poinsette, Salad cucumber, CH-20 , PCUC-6, IIHR-304, IIHR-341, Himangi
Long (>25 cm)	EUM-402-102, Green Long, CH-1, Green Salald, KC-1, COHC-42, Dharwad Local, KH-1, Sirsi Local

APPENDIX IV

Categorization of genotypes based on fruit diameter

Category	Genotype(s)
Small (<3 cm)	-
Medium (3-5 cm)	Hassan Local, NCH-1, IIHR-304
Large (>5 cm)	TMG-1, EUM-402-102, Mullu Sauthe, White Long, COHC-37, Green Long, CH-1, Green Salald, SWL, Poinsette, Salad cucumber, CH-20 , PCUC-6, IIHR-304, IIHR-341, Himangi KC-1, COHC-42, Dharwad Local, KH-1, Sirsi Local

APPENDIX V

Categorization of genotypes based on pulp texture

Pulp texture	Genotype(s)
Crispy	TMG-1, Hassan Local, EUM-402-102, Mullu Sauthe, Sambar Sauthe, White Long, COHC-37, Green Long, CH-1, SWL, Green Salad, Poinsette, Salad cucumber, KC-1, CH-20 , PCUC-6, COHC-42, NCH-1, Dharwad Local, IIHR-304, KH-1, IIHR-341, Sirsi Local
Mealy	Himangi

APPENDIX VI

Categorization of genotypes based on seediness of fruit

Category	Genotype(s)
Low (75-100)	NCH-1, IIHR-304
Medium (100-150)	Green Long, CH-1, SWL, Poinsette, Salad cucumber, CH-20, PCUC-6, COHC-42, IIHR-341
High (>150)	TMG-1, Hassan Local, EUM-402-102, Mullu Sauthe, Sambar Sauthe, COHC-37, Green Salad, White Long, Himangi, KC-1, PCUC-6, COHC-42, Dharwad Local, KH-1, Sirsi Local