

**MORPHOLOGICAL CHARACTERIZATION OF
CUCUMBER GENOTYPES FOR IMPROVEMENT
OF LOCAL CULTIVAR (*Cucumis sativus* L.)**

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BAGALKOT- 587 102, KARNATAKA, INDIA**

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**MORPHOLOGICAL CHARACTERIZATION OF
CUCUMBER GENOTYPES FOR IMPROVEMENT
OF LOCAL CULTIVAR (*Cucumis sativus* L.)**

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By

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**UNIVERSITY OF HORTICULTURAL SCIENCES, BAGALKOT
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CERTIFICATE

This is to certify that the thesis entitled “**MORPHOLOGICAL CHARACTERIZATION OF CUCUMBER GENOTYPES FOR IMPROVEMENT OF LOCAL CULTIVAR (*Cucumis sativus* L.)**” submitted by **Miss. DEEPA S. K ID No. UHS16PGM729** for the degree of **MASTER OF SCIENCE (HORTICULTURE)** in **VEGETABLE SCIENCE** to the University of Horticultural Sciences, Bagalkot is a record of research work carried out by her during the period of her study at University of Horticultural Sciences, Bagalkot, under my guidance, supervision and the thesis has not previously been formed the basis for the award of any other degree, diploma, associateship, fellowship or similar titles.

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*Affectionately Dedicated to
My Everloving Family
Teachers and Friends*

CONTENTS

Sl. No.	Chapter Particulars	Page No.
	CERTIFICATE	iii
	ACKNOWLEDGEMENT	iv
	LIST OF ABBREVIATIONS	viii
	LIST OF TABLES	ix
	LIST OF FIGURES	xi
	LIST OF PLATES	xii
	LIST OF APPENDICES	xiii
1.	INTRODUCTION	1-4
2.	REVIEW OF LITERATURE	5-28
	2.1 Genetic variability Heritability and genetic advance	5
	2.2 Genetic divergence	14
	2.3 Character association	18
	2.4 Path co-efficient analysis	19
	2.5 Pest and disease incidence	21
	2.6 Varietal characterization of cucumber genotypes using DUS guidelines	26
3.	MATERIAL AND METHODS	29-48
	3.1 Experimental site	29
	3.2 Location and climate	29
	3.3 Details of the experiment	29
	3.4 Observations recorded	33
	3.5 Statistical and biometrical analysis	40
	3.6 Observations recorded for DUS characterization.	46
4.	EXPERIMENTAL RESULTS	49-142
	4.1 Genetic variability, heritability and genetic advance	49
	4.2 Genetic divergence	76
	4.3 Character association	99
	4.4 Path coefficient analysis	119
	4.5 Pest and disease incidence	134
	4.6 Varietal characterization of cucumber genotypes using DUS guidelines	136

Contd....

Sl. No.	Chapter Particulars	Page No.
5.	DISCUSSION	143-167
	5.1 Genetic variability, heritability and genetic advance	144
	5.2 Genetic divergence	150
	5.3 Correlation	156
	5.4 Path coefficient analysis	158
	5.5 Pest and disease incidence	162
	5.6 Varietal characterization of cucumber genotypes using DUS guidelines	163
6.	SUMMARY AND CONCLUSIONS	168-171
	REFERENCES	172-182
	APPENDICES	183-194

LIST OF ABBREVIATIONS

1.	%	Percentage
2.	/	Per
3.	@	At the rate of
4.	°C	Degree Celsius
5.	°Brix	Degree brix
6.	1 st	First
7.	Anon.	Anonymous
8.	ANOVA	Analysis of Variance
9.	CD	Critical Difference
10.	cm	Centi metre
11.	cv.	Cultivar
12.	DAS	Days after sowing
13.	<i>et al.</i>	and others/associates/Co-workers
14.	Fig.	Figure
15.	g	Gram
16.	HUB	Horticulture University Bagalkot
17.	<i>i.e.</i>	That is
18.	kg	Kilogram
19.	mg	Milligram
20.	No.	Number
21.	q	Quintal
22.	R	Rank
23.	SE _m ±	Standard Error of mean ±
24.	<i>viz.,</i>	Namely

LIST OF TABLES

Table No.	Title	Page No.
1.	Details of the cucumber genotypes used in the experiment	31
2.	Analysis of variance (mean sum of square) for growth, earliness, yield and quality parameters in cucumber (<i>Kharif</i> season) 2017-18	50
3.	Analysis of variance (mean sum of square) for growth, earliness, yield and quality parameters in cucumber (<i>Rabi</i> season) 2017-18	51
4.	Analysis of variance (mean sum of square) for growth, earliness, yield and quality parameters in cucumber (Pooled average over both the seasons) 2017-18	52
5.	Estimates of genetic parameters for different traits in cucumber for <i>kharif</i> season	53
6.	Estimates of genetic parameters for different traits in cucumber for <i>Rabi</i> season	55
7.	Estimates of genetic parameters for different traits in cucumber for pooled average over both the seasons	57
8.	Per cent contribution of different traits to total diversity in cucumber (<i>Kharif</i> season)	77
9.	Per cent contribution of different traits to total diversity in cucumber (<i>Rabi</i> season)	78
10.	Per cent contribution of different traits to total diversity in cucumber (Pooled average over both the season)	80
11.	Cluster composition of 30 genotypes of cucumber based on 21 traits in D^2 analysis (<i>kharif</i> season).	81
12.	Cluster composition of 30 genotypes of cucumber based on 21 traits in D^2 analysis (<i>Rabi</i> season)	82
13.	Cluster composition of 30 genotypes of cucumber based on 21 traits in D^2 analysis. (pooled)	83
14.	Average inter and intra cluster distances for 21 traits in D^2 analysis (<i>kharif</i> season).	84
15.	Average inter and intra cluster distances for 21 traits in D^2 analysis (<i>Rabi</i> season).	86
16.	Average inter and intra cluster distances for 21 traits in D^2 analysis (Pooled average over both the season).	87
17.	Cluster means for 21 traits from D^2 analysis (<i>kharif</i> season)	88

Contd.....

Table No.	Title	Page No.
18.	Cluster means for 21 traits from D^2 analysis (<i>Rabi</i> season)	90
19.	Cluster means for 21 traits from D^2 analysis (Pooled average over both the season)	92
20.	Phenotypic correlation coefficient among fruit yield per vine and its components in cucumber for <i>kharif</i> season	100
21.	Phenotypic correlation coefficient among fruit yield per vine and its components in cucumber for <i>rabi</i> season	103
22.	Phenotypic correlation coefficient among fruit yield per vine and its components in cucumber for pooled average over both the seasons	106
23.	Genotypic correlation coefficient among fruit yield per vine and its components in cucumber for <i>kharif</i> season.	110
24.	Genotypic correlation coefficient among fruit yield per vine and its components in cucumber for <i>rabi</i> season	113
25.	Genotypic correlation coefficient among fruit yield per vine and its components in cucumber for pooled average over both the seasons	116
26.	Phenotypic path coefficient for fifteen yield components on fruit yield per vine in cucumber for <i>kharif</i> season.	120
27.	Phenotypic path coefficient analysis for fifteen yield components on fruit yield per vine in cucumber for <i>rabi</i> season	121
28.	Phenotypic path coefficient analysis for fifteen yield components on fruit yield per vine in cucumber for pooled average over both the seasons	123
29.	Genotypic path coefficient analysis for fifteen yield components on fruit yield per vine in cucumber for <i>kharif</i> season	128
30.	Genotypic path coefficient analysis for fifteen yield components on fruit yield per vine in cucumber for <i>rabi</i> season	129
31.	Genotypic path coefficient analysis for fifteen yield components on fruit yield per vine in cucumber for pooled average over both the seasons	130
32.	Response of cucumber genotypes for fruit fly incidence.	135
33.	Response of cucumber genotypes for powdery and downy mildew incidence.	137
34.	Description of morphological DUS descriptors of cucumber genotypes	138
35.	Mean values for yield attributing traits of high yielding varieties	167

LIST OF FIGURES

Figure No.	Title	Page No.
1.	Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h^2) and genetic advance over mean (GAM) for growth, earliness, yield and quality parameters in cucumber (<i>Kharif</i> season)	145
2.	Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h^2) and genetic advance over mean (GAM) for growth, earliness, yield and quality parameters in cucumber (<i>Rabi</i> season)	146
3.	Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h^2) and genetic advance over mean (GAM) for growth, earliness, yield and quality parameters in cucumber (Pooled average both the season)	147
4.	Per cent contribution of different traits to total diversity in cucumber (<i>Kharif</i> season)	153
5.	Per cent contribution of different traits to total diversity in cucumber (<i>Rabi</i> season)	154
6.	Per cent contribution of different traits to total diversity in cucumber (Pooled average over both the season)	155
7.	Genotypic correlation coefficient among fruit yield per vine and its components in cucumber for <i>kharif</i> season	159
8.	Genotypic correlation coefficient among fruit yield per vine and its components in cucumber for <i>rabi</i> season.	160
9.	Genotypic correlation coefficient among fruit yield per vine and its components in cucumber for pooled average over both the season	161

LIST OF PLATES

Plate No.	Title	Page No.
1.	General view of the experimental plot	32
2.	Cucumber accessions used in the experiment	63
3.	Variability in cucumber genotypes for cutview of fruits	65
4.	Variability in cucumber genotypes used in the experiment	75
5.	High yielding cucumber varieties identified	166

LIST OF APPENDICES

Appendix No.	Title	Page No.
I.	Meteorological data recorded during the period of experimentation (2017-2018) at Agriculture research station, Arabhavi	183
II	<i>Per se</i> performance of cucumber genotypes for growth, earliness, yield and quality parameters.	184
III	Morphological DUS descriptors of cucumber	194

1. INTRODUCTION

Cucumber (*Cucumis sativus* L.) is an important member of the family Cucurbitaceae, with a chromosome number $2n = 14$, which comprises of 117 genera and 825 species, grown in warmer parts of the world (Gopalakrishnan, 2007). The genus *Cucumis* consists of about 30 species distributed over two distinct geographical areas, south east of Himalayan group and African group. It is one of the oldest vegetable crop and has been domesticated in India for 3000 years (De Candolle, 1982), in Eastern Iran and China probably for 2000 years. Cucumber was introduced from India to China, Asia Minor, North Africa, Southern Europe and subsequently to entire Europe. It was introduced to the new world by Columbus who planted it in Haiti in 1494 and afterwards it was brought to the USA. It was grown by the ancient Greeks and Romans in about 300 B.C. It was cultivated almost throughout the middle ages and was common in France in 9th century, in England in 1327 A.D. (Thamburaj and Singh, 2014).

The crop is grown throughout the world and is the fourth most important vegetable crop after tomato, cabbage and onion. The most economically important cucurbits according to world total production are watermelon, cucumber and melon (Anon. 2006). Cucumber has diverse array of unisexual or bisexual flowering sex phenotypes (Nam *et al.*, 2005). Four sex forms occur in cucumber, they are monoecious, gynoecious, andromonoecious, and hermaphrodite. Monoecious sex form is predominant. Cucumber is highly cross pollinated due to monoecious and gynoecious sex forms. Sex expression is an important factor which has a positive effect on yield and constitutes a major component of cucumber improvement programme (Serquen *et al.*, 1997).

Cucumber is thermophilic and frost susceptible crop, which require warm weather and bright light for its better growth and development. The optimum day and night temperature required for cucumber is 30⁰C and 18-21⁰C, respectively. Minimum temperature is 15⁰C for efficient development. Sensitivity to day light affects the yield of cucumber by defining the sex characters and also type of growth. For example, short day length promotes vegetative growth and female flower production. Cucumber needs a plentiful amount of water but waterlogging is not good for its

growth. The soil should be fertile, well-drained with a pH of 6.0-7.0. Flowering starts 40-45 days after sowing. Male flowers develop earlier than female flowers. Fruits can be harvested 1-2 weeks after flowering (Grubben and Denton, 2004; Wang *et al.*, 2007).

The fruit is a special type of berry, commonly known as 'pepo'. Immature fruits are eaten raw as salad or pickled. They are mainly used as refreshing material due to their low energy content. It is ideal for people suffering from jaundice, constipation and indigestion. It also acts as an appetizer. Seeds contain oil, which is helpful for brain development and body smoothness. Hence, it is being used in ayurvedic preparations (Robinson and Decker Walter, 1997). One hundred gram of edible cucumber fruit contain 3.0% carbohydrate, 1.0% protein, 0.5% total fat, 1.0% dietary fibre and 96 g water (Anon. 2014). However, all plant parts including fruits contain a bitter and toxic substance namely 'cucurbitacin', which is chemically tetracyclic triterpenes, the amount of cucurbitacin varies from genotype to genotype.

Karnataka is the largest producer of cucumber with production of 146.02 thousand tonnes with highest area of about 8.66 thousand hectares (Anon. 2017). Haveri, Mandya, Belgaum, Koppal, Hassan and Udupi are the main districts of cultivation. In India, many standard varieties and hybrids have been released, but there is thrust to increase the production to meet the growing population of India. To achieve this, we need to overcome major constraints like pest and diseases, develop location specific varieties having desirable horticultural and quality traits, and to make available their seeds to the farmers at a reasonable price.

Success of plant breeding programme depends mainly on the broad spectrum of genetic diversity present in the population. A wide variability will provide the breeder a greater scope for selecting desired material. Because of the limitations of biochemical markers, efforts are being directed to use morphological characterization of varieties with respect to DUS under PPV&FR Act-2001 (Distinctiveness, Uniformity and Stability) testing guidelines for characterizing germplasm diversity. Information concerning the genetic similarity of breeding material should help to maintain genetic diversity and sustain long-term selection gain by incorporating inbreeding programme. Furthermore, monitoring the genetic variability within the

gene pool of elite breeding material would make crop improvement more efficient. Hence, the determination of genetic variability and its partitioning into various component is necessary to have an insight into the genetic nature of yield and its components.

Germplasm evaluation and characterization for economically important traits are prerequisite for genetic improvement of a crop. The genetic diversity in cucumber presents an opportunity to select superior types and obtain improvement in yield. The presence of variability provides opportunity for improvement of different quantitative and qualitative characters. The study of variability for various characters is prerequisite for a plant breeder to develop a high yielding variety with good quality.

The genetic parameters such as genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h^2), genetic advance over mean (GAM) enable selection on a sound genetic basis, leading to improvement in the yield. However, selection based on yield alone is often misleading, because it is one of the most complex characters dependent on various components for its full expression. For rational improvement of yield and its components, association of component characters with yield and among the components themselves should be found out by estimating the correlation coefficients.

Association of characters determined by correlation coefficient, although useful will not provide an exact picture of the relative importance of direct and indirect influence of each of the characters towards yield. Path coefficient analysis developed by Wright (1921) has been employed in many vegetables in order to overcome the unreliability of correlation coefficient. This technique involves effective partitioning of the correlation coefficient into measures of direct and indirect effects on yield. This work can help to reveal information about economically useful traits in cucumber for breeding programme (Rao and Hodgkin, 2002).

Cucumber is highly cross-pollinated crop and native of India which exhibit considerable variation for different traits, but very meagre work has been done for the improvement of local types. Therefore, evaluating locally adopted cucumber genotypes for commercial cultivation is priority area of research in improving the

productivity, uniformity, fruit quality and market acceptance. With this background it is worthy to take up the present investigation to have desirable horticultural and quality traits.

Objectives:

1. To study the genetic variability and diversity for growth, quality, yield and earliness traits in cucumber genotypes.
2. To study the association of growth, quality and earliness with yield traits in cucumber genotypes.
3. Characterization of cucumber genotypes based on DUS test guidelines.

2. REVIEW OF LITERATURE

A detailed and comprehensive review of literature is prerequisite for any scientific investigation. Proper understanding of the study requires thorough review of existing knowledge related to that study. The review of literature on the present investigation entitled “Morphological characterization of cucumber genotypes for improvement of local cultivar (*Cucumis sativus* L.)” are presented under the following heads keeping in view the objectives of the present investigation.

2.1 Variability, Heritability and Genetic advance

2.1.1 Genetic variability

The success of any breeding programme depends on the extent of variability existing in the germplasm. Variability may be defined as the amount of variation present among the member of a population or species for one or more characters at genotypic or phenotypic levels. An inclusive summary of the method used for estimation of genetic variance is presented by Cockerham (1963). Phenotypic variability is noticeable and it includes both genotypic and environmental variation and hence called total variation. Genotypic variation refers to genetic or inherent variability, which remains unchanged by environmental conditions. It is in terms of genotypic variances and consists of additive, dominance and epistatic components. environmental variance is measured in terms of error mean variance (Chaudhary *et al.*, 1985). Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) are derived by mean and are used to assess the magnitude of variation. Variability for growth, earliness, yield and yield components in cucumber has been reported by several workers. The review of literature on variance and its components for various characters have been presented below.

Kanwar *et al.* (2003) reported a wide range of variation with respect to different traits, except for harvest duration. Phenotypic and genotypic coefficient of variability were maximum in sex ratio, node of first female flower and yield per plant, thus indicating that these characters might respond to selection

Rakhi and Rajamony (2005) observed highest PCV and GCV in musk melon for fruit yield per plant followed by fruit weight, fruits per plant and sex ratio. Lowest PCV and GCV for days to first harvest, days to produce first female and male flower.

Afangideh and Uyoh (2007) studied variability in cucumber, highest PCV and GCV were observed for the characters number of leaves at 6 weeks, days to fifty per cent flowering, number of staminate flowers and total fruit yield.

A wide range of variability along with high estimates of PCV and GCV were observed for days to first female flower anthesis, number of primary branches per plant, number of node bearing female flower, fruit length, fruit weight, cavity of fruit and fruit yield per plant in cucumber as given by Kumar *et al.* (2008).

Tomar *et al.* (2008) reported high genotypic and phenotypic coefficient of variation for fruit yield per plant, number of fruits per plant and total soluble sugars. Fruit length and days to first picking exhibited very low GCV and PCV in muskmelon.

Yogesh *et al.* (2009) observed the wide range of variability for number of female flower per plant, fruit weight of edible stage, days to first fruit harvest and number of days to first female flower anthesis in cucumber.

Mehdi and Khan (2009) observed high PCV and GCV in cucumber for characters like fruit girth, fruit length, fruit weight, number of fruits per plant and fruit yield per plant.

Arunkumar *et al.* (2011) reported high to moderate PCV and GCV for number of fruits per vine and low PCV and GCV was observed for days to first male flower, days to first female flower, days to first harvest, vine length and average fruit weight in cucumber.

Gaikwad *et al.* (2011) observed high genotypic as well as phenotypic coefficient of variation for characters such as pest and disease incidence followed by length of fruit, number of fruits per vine, weight of fruit and node number of first female flower in cucumber.

Rana and Pandit (2011) reported high GCV and PCV in snake gourd for length of fruit, yield of fruit, total number of fruits per plant, total number of male flowers. GCV were lower ranging from 5.12 to 24.12 per cent while PCV ranged from 11.83 to 35.24.

Basavarajeshwari *et al.* (2012) recorded that moderate to high GCV and PCV were observed for vine length, number of primary branches at 75 days after sowing (DAS), nodes up to first female flower, number of fruits per plant and fruit yield per plant in cucumber.

Golabadi *et al.* (2012) assessed genetic variation in cucumber genotypes and recorded highest PCV for fruit number per node followed by vigour of plant, number of branches per plant. Highest GCV was noted for vine length, vigour of plant and fruit number per node.

Ullah *et al.* (2012) observed highest PCV and GCV in cucumber for yield per plant, fruits per plant, fruit weight and fruit length. Lowest PCV and GCV for days to harvest and days to flowering.

Veena *et al.* (2012) recorded highest PCV and GCV for node of first female flower appearance followed by node of first female flower appearance, yield per plant, seed cavity breadth, average fruit weight and number of fruits per plant. Whereas, low for days to first fruit harvest, days to first male and female flower opening, vine length and number of nodes per vine.

PCV and GCV were comparatively high for days to first female flower anthesis followed by node number bearing female flower, number of branches per vine, vine length, fruit yield per vine, cavity of fruit, node numbers bearing first male flower and numbers of fruits per vine in cucumber as given by Yadav *et al.* (2012).

Kumar *et al.* (2013) reported high GCV for yield per plot and node number bearing first female flower. PCV was high for node number bearing first female flower, severity of anthracnose and yield per plot. Low GCV and PCV were recorded for fruit breadth and fruit length.

Reddy *et al.* (2013) stated that the estimates of PCV and GCV were highest for fruit yield followed by rind thickness, average fruit weight and fruit length. While lowest for days to appearance of first pistillate flower followed by days to last fruit harvest and days to first fruit harvest.

Sharma and Sengupta (2013) recorded high estimates of PCV and GCV in bottle gourd for fruit length followed by number of primary branches per vine, fruit width. However low estimates of PCV and GCV were noted for characters like days to first appearance of female flower and days to first appearance of male flower.

Jat *et al.* (2014) reported maximum PCV and GCV in kakri for weight of fruit followed by total yield per vine, rind thickness and total soluble solids.

Khan *et al.* (2015B) observed significant variation for all the characters among the genotypes. Highest genotypic and phenotypic co-efficient of variation were observed for branches per vine, fruit length, fruit weight and number of fruits per plant in bitter gourd.

Ranjan *et al.* (2015) observed high PCV and GCV for node number bearing first female flower, number of primary branches, fruit weight, fruits per plant and seeds per fruit.

Ene *et al.* (2016) reported highest PCV and GCV for the number of branches followed by vine length, fruit weight per plant, and leaf area in the early planting season. For the late planting season, the highest PCV and GCV were recorded in fruit weight per plant followed by number of branches, vine length, and total fruit yield per hectare. While days to 50 percent female flowering had the lowest PCV and GCV at both the seasons.

Pal *et al.* (2016) recorded high PCV and GCV for node number bearing first female flower, number of fruits per plant, number of primary branches per plant, yield per plant, severity of anthracnose, downy mildew and powdery mildew.

Pushpalatha *et al.* (2016) assessed the variability in twenty-four cucumber genotypes. Results revealed highest phenotypic and genotypic coefficient of variation for yield per plant, flesh thickness, number of fruits per plant, number of nodes per plant, number of branches per plant, average fruit weight, internodal length and vine length.

Kandasamy (2017) recorded maximum PCV and GCV in cucumber for yield per plant followed by average fruit weight, fruit diameter and number of fruits per

plant. Lowest PCV and GCV were observed for days to first female flower and days to first harvest.

The genotypic and phenotypic coefficient of variation were high for characters such as number of primary branches per plant, node number at which first female flower appears, fruit length, fruit weight, number of seeds per fruit, total soluble solids, ascorbic acid and fruit yield per vine indicating the presence of wider genetic variability for these traits as given by Kumar *et al.* (2017).

Rajawat and Collis (2017) reported maximum PCV and GCV for number of female flowers per vine, number of male flowers per vine, fruit yield per vine, number of branches per vine, number of fruits per vine, node number at which first male flower appears, node number at which first female flower appears and fruit length in cucumber.

Rawat *et al.* (2017) noted the maximum phenotypic and genotypic coefficient of variation (PCV and GCV) in cucumber for node number to first female flower, number of primary branches per plant, average fruit weight and fruit yield. While lowest PCV and GCV for days to appearance of first female flower, days to first picking, fruit length and fruit diameter.

Shah *et al.* (2017) observed high GCV and PCV for number of nodes bearing first male flower whereas, moderate PCV and GCV were observed for number of nodes bearing first female flower, leaf area, length of fruit, TSS and weight of fruit.

Highest GCV and PCV were found for characters like fruit length followed by fruit yield, node number to first female flower, fruit diameter, internodal length and number of fruits per plant indicating maximum variability as reported by Ahirwar and Singh (2018) in cucumber.

2.1.2 Heritability and genetic advance

Heritability is the transmissibility of the characters from parent to off spring. Effectiveness of selection of genotypes is determined by the heritability. In crop improvement the genetic component of variation is important since only this component is transmitted to the next generation. The ratio of genotypic variance to

phenotypic variance is known as heritability. It represents the proportion of phenotypic variance that is due to that genotype *i.e.*, heritable. The heritability thus estimated is termed as broad sense heritability and serve as useful tool in the process of selection by the breeder.

Genetic advance is the measure of the improvement that can be achieved by practicing selection in a population. Since, the estimates of heritability give no indication of the amount of progress expected from the selection they are most meaningful when accompanied by estimates of genetic advance. High genetic advance coupled with high heritability is an indication of more additive gene action. Heritability and genetic advance for growth, earliness, yield and yield components in cucumber has been reported by several workers. The review of literature on heritability and genetic advance as per cent of mean for various characters have been presented down below.

Kanwar *et al.* (2003) reported that all the characters exhibited high heritability except for harvest duration. The high heritability estimates were associated with high genetic gain for sex ratio, yield per plant and node of first female flower. Thus, suggesting that the additive gene effects were important in the inheritance of these characters and considerable improvement could be made by selection.

Rakhi and Rajamony (2005) recorded high heritability along with high genetic advance in muskmelon for fruit length, average fruit weight, fruits per plant and sex ratio.

Afangideh and Uyoh (2007) reported high heritability (broad sense) estimates for days to flower initiation and days to 50 per cent flowering. GAM was found high for the character length of vine at sixth week. Low for days to flower initiation and days to 50 per cent flowering.

High heritability along with high expected genetic gain was observed for days to first female flower anthesis, number of primary branches per plant, number of fruits per plant, fruit length, fruit diameter, cavity of fruit and fruit yield per plant in cucumber as given by Kumar *et al.* (2008).

Tomar *et al.* (2008) noted that fruit yield per plant, total soluble sugars, number of fruits per plant, number of the node at which first female flower appeared and fruit weight had very high to moderate heritability coupled with high to moderate genetic advance (as per cent mean) in muskmelon.

Mehdi and Khan (2009) observed high heritability along with high genetic advance in cucumber for characters like fruit girth, fruit length, fruit weight, number of fruits per plant and fruit yield per plant.

Arunkumar *et al.* (2011) reported high heritability for days to first female flower, vine length, number of nodes per vine, number of branches per vine, number of male flowers per vine, days to first harvest, fruit length, fruit diameter, average fruit weight, number of good fruits per vine and total fruit yield per vine.

Arunkumar *et al.* (2011) observed high genetic advance over mean for number of fruits per vine, number of misshaped fruits per vine, total number of fruits per vine, days to first male flower, number of female flower per vine, number of branches per vine and length of fruit.

Basavarajeshwari *et al.* (2012) reported that high heritability coupled with high genetic advance over mean was observed for the characters *viz.*, vine length, nodes up to first female flower, number of fruits per vine, fruit yield per vine and number of seeds per fruit indicating predominance of additive components.

Gaikwad *et al.* (2011) recorded high heritability for almost all the characters, highest being length of fruit, days to first harvest, weight of fruit and days to appearance of first female flower. Characters final vine length and weight of fruit were recorded for high percentage of heritability coupled with high estimates of genetic advance.

Rana and Pandit (2011) noted high to moderate estimates of heritability as well as GAM for days to seedling emergence, number of seeds per fruit, days to 50 per cent female flower opening, days to first fruit setting, days to first female flower opening, days to 50 per cent fruit setting and total number of male flowers in snake gourd.

Ullah *et al.* (2012) reported that the attributes like fruit weight, fruit length, fruits per plant, yield per plant and days to flowering had shown high to moderate heritability as well as genetic gain in cucumber.

Veena *et al.* (2012) recorded high heritability estimates for characters like number of nodes per vine, node of first female flower appearance appears, days to first female flower opening, days to first male flower opening, days to first harvest, number of fruits per plant, fruit length and fruit breadth. High genetic advance over mean coupled with high heritability was observed in characters like node of first female flower appearance appearance and days to first female flower opening.

Yadav *et al.* (2012) in the present study reported that high genetic advance coupled with high heritability were observed for number of branches per vine followed by cavity of fruit, fruit yield per vine, number of fruits per vine and fruit length.

Kumar *et al.* (2013) reported that the estimates of heritability was found high for the characters *viz.* yield per plot, fruit length and fruit breadth. Low heritability for severity of anthracnose and node number bearing first female. GAM was found high for the character average fruit weight. Low GAM was recorded for TSS (⁰Brix), fruit breadth and node number bearing first female flower.

Reddy *et al.* (2013) recorded high estimates of heritability (>60%) coupled with high GAM (>20%) for days to appearance of first staminate flower, fruit length, average fruit weight, fruit cavity width, rind thickness and total soluble solids.

Sharma and Sengupta (2013) observed high heritability for vine length, fruit length, fruit width, days to first appearance of male and female flower, primary branches per vine, fruit weight, nodes per fruit set, nodes per vine up to first female flower, internodes per vine, yield per vine and number of fruit per vine. High genetic advance as per cent of mean was observed in fruit length followed by fruit weight in bottle gourd.

Jat *et al.* (2014) observed high estimates of heritability along with high genetic advance in kakri for days to anthesis of first female flower, weight of fruit and

diameter of fruit. The maximum genetic gain in per cent was observed for weight of fruit, total yield per vine and rind thickness.

Ranjan *et al.* (2015) reported high heritability along with high genetic advance as per cent of mean for node number bearing first female flower, fruits per plant and seeds per fruit. Moderate for number of primary branches and fruit weight.

Ene *et al.* (2016) recorded high heritability for vine length, leaf area and number of leaves in both early and late planting seasons, respectively. High genetic advance for vine length and leaf area at both early and late planting seasons, respectively.

Pal *et al.* (2016) noted high heritability (>80%) coupled with high genetic gain (>50%) for the traits node number bearing first female flower, number of fruits per plant, number of primary branches per plant, yield per plant, severity of anthracnose, downy mildew and powdery mildew.

Pushpalatha *et al.* (2016) assessed heritability for growth and yield traits in cucumber and obtained highest heritability coupled with high genetic advance as per cent of mean for yield per plant, flesh thickness, number of fruits per plant, number of nodes per plant, number of branches per plant, average fruit weight, internodal length and vine length.

Kandasamy (2017) observed high heritability associated with greater genetic gain for yield per plant, fruit diameter, average fruit weight, number of secondary branches and number of fruits per plant.

Kumar *et al.* (2017) stated that the characters like primary branches per plant, days to first male flowering, days to first female flowering, days to 50 percent male flowering, days to 50 percent female flowering, days to first fruit harvest, days to last harvest, number of seeds per fruit, TSS, ascorbic acid and fruit yield per vine recorded high heritability in conjunction with high genetic advance as per cent mean.

Rajawat and Collis (2017) in their study reported high genetic advance over mean coupled with high heritability in characters like number of male flowers per vine, vine length and fruit weight. Higher heritability estimates were accompanied by

lower genetic advance over mean for vitamin C, TSS, fruit yield per vine and days to first fruit harvest in cucumber.

Rawat *et al.* (2017) reported that high estimates of heritability (broad sense) was observed for number of primary branches per plant, fruit yield, average fruit weight, main vine length, number of fruits per plant and internodal length. While maximum GAM was observed for number of primary branches per plant, node number to first female flower, average fruit weight and fruit yield.

Shah *et al.* (2017) recorded high heritability for leaf area and length of fruit. High heritability coupled with high GAM was noticed for number of nodes bearing first male flower, leaf area, length of fruit, number of nodes bearing first female flower, number of fruit per vine and TSS.

In cucumber fruit weight and fruit length showed maximum heritability. However high heritability coupled with high genetic advances as per cent of mean for node number to first male flower, node number to first female flower, plant height and number of fruits per plant as reported by Ahirwar and Singh (2018).

2.2 Genetic divergence

The parents chosen for hybridization need to be genetically diverse or distant for getting high heterosis or for recovering transgressive segregants. The cultivars from widely separated localities have been usually included in the hybridisation programme, presuming the presence of genetic divergence and parents results in superior hybrids and desirable recombinants. Eco-geographical diversity has been regarded as a reasonable index of genetic diversity (Vavilov, 1926 and Moll *et al.*, 1962). However, it was reported later that, there does not exist any parallelism between geographic distribution and genetic diversity (Sachan and Sharma, 1971; Peter, 1975).

Multivariate analysis has been put to good use enabling quantification of degree of divergence between populations (Michener and Sokal, 1957; Morishina and Oka, 1960; Murty and Qadri, 1966). Several methods of divergence analysis based on quantitative traits have been proposed to suit various objectives, of which Mahalanobis's generalised distance (Mahalanobis, 1936) occupy a unique place in

plant breeding. It is a very sensitive and potent biometrical tool in quantifying the degree of divergence between biological populations and also to assess the relative contribution of different components to the total divergence both at inter- and intra-cluster levels (Nair and Mukherjee, 1960; Khanna and Misra, 1977; Singh and Singh, 1980). The concept of Mahalanobis's D^2 statistic is based on the technique of utilising the measurements in respect of aggregate of characters. The D^2 statistic as a measure of genetic divergence was used for the first time in the field of plant breeding by Nair and Mukherjee (1960) in the classification of natural and plantation teak. The relative studies on the analysis of genetic divergence in cucumber are just countable and those which have been published are reported here along with similar studies on other related vegetable

Singh and Lal (2005) studied fifty-one genotypes of muskmelon and snap melon for magnitude of genetic diversity using Mahalanobis D^2 analysis. Considering twelve different characters, the fifty-one strains were grouped into 13 clusters. Intra cluster distance values ranged from 0.00-19.58. It was maximum in cluster III (19.58). The inter cluster distance (D^2 values) was maximum between cluster VII and cluster XII (49.92). Maximum divergence was provided by nodes at which first female flower opened and minimum by total fruit yield per vine.

Sharma and Sharma (2006) grouped the thirty-one genotypes of cucumber into seven clusters by cluster analysis. Intra-cluster distances revealed that the maximum divergence was present in cluster II (1.319), followed by cluster VI (1.135) and cluster VII (1.127). The lowest value of intra-cluster distance (0.769) was observed for cluster III. The maximum inter-cluster distance (4.875) was observed for cluster II and cluster III, followed by cluster III and cluster VI (4.703), cluster I and cluster IV (4.251), and cluster III and cluster IV (4.221).

Tomar *et al.* (2008) formed seven clusters from 50 accessions of cucumber to study divergence. Intra- and inter-cluster average values ranged from 0.00 to 41.24 and 21.35-138.78. The maximum intra-cluster distance was observed for cluster V (41.24). The inter-cluster distance was maximum between clusters II and V (138.78), followed by clusters IV and V (124.24), clusters V and VI (104.56) and clusters I and II (83.55). The minimum inter-cluster distance was observed between clusters III and VII (21.35), followed by clusters IV and VI (21.46).

Gaikwad *et al.* (2011) assessed genetic divergence in eighteen cucumber genotypes grouped into eight clusters. The maximum inter cluster divergence was observed between clusters F and H (11.24) followed by C and H (10.53). Lowest between C and F (5.33) and D and E (5.65). The maximum intra-cluster distance was observed at cluster A (5.26), B (5.41) and E (5.31). While the cluster C, D, F, G and H comprising of a single genotype each showed no intra cluster distance.

Mehta *et al.* (2012) grouped 45 diverse genotypes of muskmelon into 7 clusters to estimate the nature and magnitude of genetic diversity. The intra cluster distance ranged from 0.00 to 40.22. Maximum intra cluster distance was found in cluster V (40.22) followed by II (39.90) and I (34.31). The inter cluster distance was maximum between clusters II and V (139.86) followed by cluster IV and V (121.89), cluster V and VI (103.75) and cluster I and II (82.62). Minimum between clusters III and VII (20.94) and cluster V and VI (22.46).

Punitha *et al.* (2012) studied genetic divergence in cucumber by the application of clustering technique. The 41 genotypes were grouped into eight clusters. D^2 values corresponding to all possible combinations among 41 genotypes ranged from 77.89 to 11908.88. The intra-cluster generalized distance ranged from 8.83 in cluster II to 33.10 in cluster I. The highest inter cluster divergence was recorded between the cluster VII and VIII (109.13) while cluster II and III were the closest (20.22).

Resmi and Sreelathakumary (2012) conducted genetic divergence study in 33 bitter gourd genotypes for twenty characters grouped into five clusters. Intra-cluster distance was highest in cluster-I (1197.78), followed by clusters-III and V (1149.66 and 903.03, respectively). Highest inter-cluster distance was observed in clusters-III and IV (2515.57), followed by clusters-II and III (2088.12) and clusters-I and IV (1856.82). Genetic distance (D^2) between clusters-I, III and V was larger than in cluster-IV. Minimum inter cluster distance was observed between clusters-I and V (1022.33). The best cluster with yield and other component characters was represented by cluster-II followed by cluster-IV.

Kumar *et al.* (2013) estimated genetic divergence in cucumber by grouping 30 genotypes into 4 clusters. Cluster IV showed maximum intra-cluster distance (2.494)

followed by cluster I (2.443), cluster II (2.410) and cluster III with minimum intra-cluster distance (2.383), respectively. In inter-cluster distance, the maximum divergence was observed between cluster II and III (6.168). Lowest (3.432) inter-cluster distance was recorded between cluster I and III.

Singh *et al.* (2013) based on the relative magnitude of D^2 values grouped 30 bitter gourd genotypes into 6 clusters. The intra cluster distance ranged from 0 to 383.71 and inter cluster distance ranged from 55.74 to 337.00. Maximum inter cluster D^2 value was observed between cluster-IV and cluster-V (691.012) followed by cluster-IV and cluster-II (625.318). Cluster-IV had the highest mean value for yield per plant (1.352 kg) and average fruit weight (17.52g). Number of average fruit weight contributed maximum to total divergence (64.14%) followed by days to first female flower appearance (17.01%).

Ara *et al.* (2014) grouped 28 bottle gourd genotypes into 5 clusters using D^2 analysis. The average intra cluster distance ranged from 1.179 (cluster I) to 1.301 (cluster II). The maximum inter cluster distance was between cluster III and cluster I (31.10) followed by cluster II and cluster I (26.97), minimum distance was between cluster IV and cluster II (6.51). Characteristics like yield (t/ha) (0.97%), number of fruits per plant (7.91%), fruit weight (5.75%) and fruit length (0.69%) were important contributors towards genetic divergence among the genotypes in the study.

Hasan *et al.* (2015) categorized seven cucumber genotypes into three different clusters. The highest inter-cluster distance (4.078) was observed between cluster I and II, whereas lowest inter-cluster distance (1.011) was observed between the clusters I and III. Cluster II showed highest mean for length of main vine, nodes per plant, primary branches per plant, days to first male flowering, length of internodes, fruits per plant and yield per plant. Whereas cluster III produced highest mean for fruit length, fruit diameter and fruit weight. Cluster II and III contributed 53.85% and 38.46%, respectively towards divergence.

Ahiwar *et al.* (2017) grouped 46 germplasm along with a check of cucumber into 7 clusters. In analysis, the maximum intra cluster distance was noticed in cluster IV (8.81) followed by cluster II (7.37) and cluster I (5.63) whereas minimum intra cluster distance recorded in cluster III, cluster V, cluster VI and cluster VII (0.000).

Maximum inter cluster distance was noticed between cluster IV and cluster VII (25.49) followed by cluster III and cluster IV (24.54), cluster IV and cluster V (23.57). Minimum inter cluster distance was noticed between cluster III and cluster VI (7.32).

Sharma *et al.* (2018B) assessed the nature and magnitude of genetic divergence for 30 genotypes of cucumber grouped into 5 clusters using Mahalanobis D^2 statistics. The intra cluster distance was maximum in cluster IV (3.469) and minimum in cluster III (1.776). Highest (6.221) inter cluster distance was recorded between cluster III and IV and lowest (2.502) was observed between cluster I and II. Cluster III performed better for majority of traits *viz.* node number bearing first female flower, number of marketable fruits per plant, average fruit weight, days to marketable maturity, TSS, severity of powdery mildew and yield per plot. Maximum fruit length (21.42), minimum severity of anthracnose was recorded in cluster V (7.48), while fruit breadth was highest in cluster IV (5.50).

2.3 Character association

Correlation study measures the natural relationship between various characters and helps in determining the component characters on which selection can be done for yield improvement. Correlation among traits and with yield is important in indirect selection of genotypes for yield improvement (Machikowa and Laosuwan, 2011). Significant and positive correlation between two characters suggests that these characters can be improved simultaneously in a selection programme (Hayes *et al.*, 1955).

Correlation coefficient measures the degree of association either in positive or negative direction. Phenotypic correlation is the visible correlation between two variables, which includes both genotypic and environmental effects. Genotypic correlation on the other hand, is the inherent association between two variables and it may be either due to pleiotropic action of genes or linkage or both. Environmental correlation arises completely due to environmental effects. Review of literature on correlation studies are presented down below.

Prasad and Singh (1994) observed that the yield per plot was highly significant and positively correlated with vine length, flesh thickness and placental thickness.

Days to first female flower appearance had a significantly negative correlation with flesh thickness in cucumber.

Choudhary *et al.* (2004) reported that yield per plant had significant positive correlation with fruit weight, fruits per plant, number of vines per plant, harvest duration, rind thickness and vine length in muskmelon.

Dhiman and Prakash (2005) studied correlation in cucumber and reported that number of fruits per vine, fruit weight, fruit length, fruit diameter, vine length, days to first male flowering and days to first female flowering had positive and significant correlation with fruit yield.

Afangideh and Uyoh (2007) observed that number of fruits per plant and length of vine at sixth week correlated positively and significantly ($P < 0.01$ and $P < 0.05$, respectively) with fruit yield while days to flower initiation and days to 50 per cent flowering showed negative correlation with yield.

Hanchinamani and Patil (2008) reported that number of fruits per vine, number of primary branches per plant, fruit length, fruit diameter, number of nodes per vine, vine length and internodal length showed positive and significant correlation with fruit yield. Whereas days to first male flowering and days to first fruit harvest were negatively correlated with total fruit yield.

Tomar *et al.* (2008) stated that fruit yield was positively correlated with fruit weight, fruit girth, flesh girth, flesh thickness and number of fruits per plant at both genotypic and phenotypic level. While, it had significant and positive correlation with fruit length at the genotypic level only. On the other hand, it showed significant and negative correlation with total soluble solids at both phenotypic and genotypic level in musk melon.

Mehta *et al.* (2009) reported that fruit yield was positively and significantly correlated with fruit weight, fruit girth, fruits per plant and pulp thickness at both genotypic and phenotypic levels. On the other hand, fruit yield showed significant and negative correlation with total soluble solids at both genotypic and phenotypic levels in muskmelon.

Singh *et al.* (2009) noted positive and significant correlation coefficient for fruit yield per plant with number of primary branches per plant, number of fruits per plant and fruit weight per plant.

Arunkumar *et al.* (2011) observed total fruit yield per vine had positive and significant correlation with total number of fruits per vine, average fruit weight, fruit length, fruit diameter, number of primary branches per vine, number of nodes per vine and vine length. While negatively associated with days to first male flowering, days to first female flowering and days to first fruit harvest in cucumber.

Fruit yield had significant positive genotypic and phenotypic correlation with total number of fruits. While primary branches and total number of nodes showed significant and positive genotypic correlation, but width of fruits showed significant negative genotypic correlation in snake gourd as given by Rana and Pandit (2011).

Ullah *et al.* (2012) noted that fruit yield per plant showed high significant positive correlation with fruits per plant, fruit weight, flesh thickness, fruit diameter and leaves per plant. Partial correlation was significant for fruits per plant and indicated these traits contributed over 70 per cent to total fruit yield in cucumber.

Khan *et al.* (2015A) observed that fruit characters like fruit length, fruit diameter, individual fruit weight and number of fruits per plant had the high degree of significant and positive association with yield per plant in bitter gourd.

Khan *et al.* (2015B) studied correlation analysis in cucumber and reported that yield was positively and significantly correlated with fruit length (0.523) and fruit width (0.439). While fruits per plant showed positive significant correlation with vine length.

Ene *et al.* (2016) reported that vine length, number of branches, number of leaves, leaf area, number of staminate flowers per plant, number of pistillate flowers per plant, number of fruits per plant, fruit length, fruit girth, and fruit weight per plant gave positive correlation with total fruit yield. While days to male and female flower initiation, days to 50% male and female flowering were negatively correlated with total fruit yield and rest of the traits in cucumber.

Ahirwar *et al.* (2017) noted significant and positive correlation for total fruit yield with number of fruits per plant and fruit weight, days to first male flower with days to first female flower, internodal length with fruit weight, days to first fruit harvest with number of fruits per plant and test weight. Whereas, negative significant correlation for total fruit yield was observed with internodal length.

Chinatu *et al.* (2017) stated that vegetative characters like number of vines per plant, number of leaves per plant had positive and very high significant correlation coefficient with fruit yield per plant.

Kumar *et al.* (2017) reported that number of fruits per plant have exhibited highly significant positive association with fruit yield per plant followed by fruit weight, number of primary branches per plant, fruit length and vine length.

Kumari *et al.* (2018) in their study reported that the fruit yield per plant had significant and positive correlations (genotypic and phenotypic) with traits like average fruit weight, number of fruits per plant, number of pistillate flowers per plant, fruit width, vine length and number of nodes per vine.

Sharma *et al.* (2018A) in their correlation studies revealed that yield per plot had positive and significant association with number of marketable fruits per plant, average fruit weight and harvest duration. While significant negative correlation was observed with node number bearing first female flower, days to marketable maturity and severity of anthracnose both at phenotypic and genotypic levels.

2.4 Path co-efficient analysis

Correlation co-efficient alone when considered as the criterion for selection for high yield would be misleading. As such a character may directly correlate with yield but further may depend on other characters. Yield is a complex character and it is dependent upon number of components. A correlation study gives the amount of association between any pair of characters. The direct and indirect effect of the components of yield are however, not revealed by this study. Especially, when more and more variables are included in the study, the indirect contribution becomes more complex and para mixing. However, path coefficient analysis developed by Wright (1921) helps in partitioning the correlation coefficient into direct and indirect effects, thereby, providing relative importance of each causal factor.

Path analysis is simply standardized partial regression coefficient, which splits the correlation coefficients into the measures of direct and indirect effects of a set of independent variables on the dependent variable. Partitioning of the total correlation into direct and indirect effects would be worthwhile for an effective selection programme. If the correlation coefficient between causal factor and the effect is almost equal to its direct effect, then correlation explains the true relationship and a direct selection through this trait will be effective. If the correlation coefficient is positive and the direct effect is negative or negligible, the indirect effect seems to be the cause of correlation. In such situations, the indirect causal factors need to be considered simultaneously for selection. Correlation coefficient may be negative but the direct effect can be positive and high, under such circumstances, a restricted simultaneous selection model is to be followed, *i.e.*, restrictions are to be imposed to nullify the undesirable indirect effects in order to make use of the direct effects. Review of literature on path analysis in cucumber and other related crops are presented as under.

Abusalekha and Dutta (1990) reported that number of fruits per vine had a remarkably positive and significant effect on yield per plant and yield per plot in cucumber. Average fruit weight had high positive and direct effect on yield as well as indirect effect through number of secondary branches per vine, number of fruits per vine and diameter of fruits in cucumber.

Prasad and Singh (1994) observed that average fruit weight, node at which first male flower appear and fruit length had a positive and direct effect on yield. The contribution of fruit weight was mostly indirect through node number at which first female flower appear and number of fruits per plant. Days to female flower appearance, fruit weight and number of fruits per plant had indirect effect on fruit yield in cucumber.

Carmer and Wehner (2000) studied in cucumber the number of branches per plant had a direct positive effect on and was correlated with the number of fruit yield. The number of nodes per branch, the percentage of pistillate nodes and the percentage of fruit set were less correlated with total fruit number per plant (fruit yield) than the number of branches per plant.

Choudhary *et al.* (2004) reported that fruit weight, fruits per plant, rind thickness, incidence of fruit fly, TSS, days to first fruit harvest, severity of powdery mildew, severity of downy mildew showed positive direct effect on yield per plant, while other characters have shown negative effect.

Positive direct effect of average fruit weight, total number of fruits per plant, days to first fruit harvest, node at which first female flower appear on fruit yield in cucumber was reported by Hanchinamani and Patil (2008).

Tomar *et al.* (2008) studied that number of fruits per plant had the maximum positive direct effect on fruit yield and negative indirect effect through total soluble solids. Fruit length, fruit weight, fruit girth, flesh thickness had high positive direct effect on fruit yield in musk melon.

Path analysis based on genotypic association revealed that fruits per plant and total soluble solids were the main yield attributing characters in fruit yield of muskmelon, because of their high positive direct effect and positive correlation with fruit yield per plant in muskmelon by Mehta *et al.* (2009).

Singh *et al.* (2009) observed that number of fruits per plant and weight of fruit had positive direct effect on fruit yield per plant in cucumber.

Arunkumar *et al.* (2011) noted that average fruit weight, total number of fruits per plant, number of branches per vine, vine length, days to first male flower appearance and days to first female flowering had maximum direct effect on fruit yield. Total number of fruits per plant, average fruit weight, fruit diameter, days to first female flower appearance, days to first fruit harvest, vine length and number of nodes per vine had positive indirect effect on the total fruit yield in cucumber.

Rana and Pandit (2011) reported that days to first female flower opening had maximum direct effects followed by days to 50 per cent male flower opening and days to 50 per cent fruit setting. Whereas, days to 50 per cent female flower opening had the maximum indirect effect followed by days to first fruit setting, days to first male flower opening and number of fruits per plant in snake gourd.

Hasan *et al.* (2015) studied path analysis in cucumber and revealed that fruits per plant and fruit weight had maximum positive direct effect on yield followed by vine length, nodes per plant, leaf length, fruit length, fruit diameter and fruit weight. The direct effect of above mentioned characters was negligible except number of fruits per plant and fruit weight as in comparison to correlation with yield.

Khan *et al.* (2015A) observed that fruit length showed low direct and positive effect on yield per plant and indirect positive effect on yield per plant via fruit diameter and average fruit weight. Average fruit weight and number of fruits per plant showed high direct and positive effect on yield per plant. Average fruit weight, number of fruits per plant, days to male flowering and fruit length had positive direct effect on fruit yield in bitter gourd

Ene *et al.* (2016) also reported that vine length, number of staminate flowers per plant, number of fruits per plant and fruit weight per plant had positive direct effect on the total fruit yield per hectare. While, number of branches, number of leaves and number of pistillate flowers per plant consistently gave negative direct effect on the total fruit yield per hectare in cucumber.

Ahirwar *et al.* (2017) reported the maximum direct effect of number of fruits per plant followed by fruit weight, test weight, days to first male flowers and plant height on fruit yield. While maximum positive indirect effect of number of fruits per plant followed by days to first female flowers, fruit weight and node number to first female flower on fruit yield.

Kumar *et al.* (2017) stated that number of fruits per plant, fruit weight, number of primary branches per plant, fruit length, number of seeds per fruit, days to last fruit harvest, fruit diameter and number of nodes per vine have direct positive phenotypic and genotypic effect on yield. While the traits *viz.*, vine length, internodal length, number of nodes per plant, days to first male flowering, days to first female flowering, days to 50 per cent male flowering, days to first fruit harvest, TSS and powdery mildew incidence exhibited negative direct effect.

Kumari *et al.* (2018) studied path analysis at genotypic level and depicted that traits like number of fruits per plant showed maximum direct positive effect towards number of fruit yield per plant followed by average fruit weight and sex ratio. While,

in case of phenotypic path analysis, the highest direct positive effect towards fruit yield per plant was seen in traits like average fruit weight followed by number of fruits per plant and number of pistillate flowers per plant.

Sharma *et al.* (2018A) reported path coefficient analysis showed severity of powdery mildew had maximum positive direct effect on yield per plot followed by TSS, fruit length, average fruit weight, days to marketable maturity, number of fruits per plant, severity of anthracnose, harvest duration and fruit breadth. While, negative direct effect of node number bearing first female flower was observed on yield per plot.

2.5 Pest and disease incidence

Productivity of bitter melon is reduced due to fruit fly infestation and resistance or tolerant to fruit fly infestation could be due to non-attraction of pests and their harboring in those genotypes. Minimum fruit fly infestation was observed in Panruthy followed by VRBT-100 and VRBT-83. Whereas, maximum fruit fly infestation was observed in Arka Harit. A great range of variation from 20.90 (Panruthy) to 71.50 per cent (Arka Harit) with mean of 42.20 per cent was reported by Vijaykumar (2007).

Shivaprasad *et al.* (2013) subjected nine genotypes for testing for powdery mildew reaction under natural disease pressure condition and reported that none of the F₁ hybrids were resistant to this disease, the disease intensity recorded as per cent leaf area infected ranged from 17.63 to 38.70 percent with mean disease severity of 23.84 percent. The hybrid Tamanna recorded least intensity and highest in Arka Jeet. The fruit fly infestation recorded as percentage of fruits infested ranged from 10.60 to 25.41 with a mean of 17.24 percent infestation. The least infestation of fruit fly was recorded in NS-910 and highest in Arka Jeet. Out of 8 hybrids, none of them have shown less than 10 per cent infestation.

Harika *et al.* (2012) reported that genotype Anand bottle melon -1 recorded a higher incidence for fruit fly followed by Sarika, NS-443, Super Dhana, INDAM-204, Bio Gaurav and Anand were found to be highly susceptible. There was no incidence of fruit fly in the genotype Elina and is found to be resistant. Whereas, least incidence of fruit fly was reported in US-15 followed by Sharada, Arka Bahar, Champion and NBBL-52 in bottle melon.

Pal *et al.* (2016) noted that minimum severity of anthracnose (3.33 %) was recorded in LC-21 followed by LC-10 and LC-20 whereas, it was maximum in LC-26. Minimum severity of downy mildew was recorded in LC-10, which was statistically at par with LC-21, whereas, maximum disease severity was recorded in LC-26. Minimum disease severity of powdery mildew was recorded in genotypes LC-10 and LC-20, which was statistically at par with LC-2 and LC-21. Maximum severity was recorded in LC-26.

Shruthi *et al.* (2016) observed that least infestation of fruit fly was recorded in Sirsi Local followed by BCMCO-01, BCMCO-02 and BCMSO-03. Highest infestation was recorded in Sirsi-2-13. Among the genotypes, none of them had showed resistant to infestation. Least infestation of powdery mildew was found in Mysore Local followed by Sirsi Local and BCMSO-03. Whereas highest in GR-3 followed by Sirsi-1-13 and BCMCO-02. Least infestation of downy mildew was observed in BCMCO-02 followed by Sirsi Local and BCMSO-03 and highest in GR-2-1 followed by GR-4 and GR-4-1. Most of the genotypes were moderately susceptible to downy mildew.

2.6 Varietal characterization of cucumber genotypes based on DUS guidelines

The varietal characterization and varietal purity assessment are very important for maintenance of variety, hybrids, further multiplication, seed certification and quality control. The term variety is defined as an assemblage of cultivated plants, which are distinguished by morphological, physiological, chemical and cytological characters. According to international union for the protection of varieties, new crop variety has to be distinct from other varieties and uniform in its characteristics which are genetically stable in yield. The review on varietal characterization based on plant morphology is as follows.

Gichimu *et al.* (2009) morphologically characterized some wild and cultivated watermelon. The landrace was morphologically very close to inbred cultivars except for its tan coloured seeds and white flesh which was also tasteless. In addition, its female flower had an unusually hairy ovary unlike in commercial cultivars where the ovary was glabrous. Unlike the landrace, the wild accession was distantly related to

cultivated accessions in most of qualitative characters. The wild accession was also very prolific but the fruits were very small compared to those of cultivated accessions. Highly significant variation was observed between cultivated accessions (commercial cultivars and landraces) in all the quantitative characters that were measured.

Shivaprasad *et al.* (2013) evaluated performance of eight muskmelon hybrids. Highest vine length, number of leaves and fruit flesh thickness was observed in F₁ hybrid Tamanna. Maximum leaf area, number of branches per vine and number of fruits per plant were highest in F₁ hybrid Kundan. NS-910 took minimum number of days for first flowering. Average fruit weight and yield per plot recorded highest for F₁ hybrid NS-910. Tamanna took minimum number of days for first female flowering, highest fruit cavity size was observed in Arka Jeet.

Choudhary *et al.* (2015) studied morphological characterization of twelve muskmelon varieties to validate DUS guidelines. The varieties were grouped into different categories for each character based on 34 descriptors which may be used as reference varieties. The fruit shape in longitudinal section was expressed as ovate (MHY 5), elongated globe (Arka Rajhans), oblate (GMM 3, Kashi Madhu) and obovate (Durgapur Madhu). The rind color of fruit has been grouped as yellow (Kashi Madhu), yellow green (Durgapur Madhu) and orange (Arka Jeet). The sutures on fruit surface were found to be absent in Arka Jeet, MHY 3 and present in Hara Madhu, Kashi Madhu varieties. With respect to netting on fruit surface the varieties have been grouped as absent of netting (Arka Jeet, MHY 5) and moderate netting (RM 50, Punjab Sunehri). The flesh color was expressed as creamish white (Arka Jeet), grey orange (GMM 3), yellowish green (Durgapur Madhu), green (Hara Madhu) and orange (Kashi Madhu).

Choudhary *et al.* (2016) developed DUS testing guidelines of 10 varieties of watermelon. All varieties were grouped into different categories for each character based on 27 descriptors. Among qualitative characters, degree of primary lobing of leaf blade, fruit shape in longitudinal section, rind color of fruit, fruit stripes, flesh color, and seed coat color were grouping characters. Among quantitative traits fruit size and seediness of fruits were identified as grouping traits for DUS testing. Variability specifically to degree of leaf blade lobing (primary and secondary) in

Durgapur Lal, yellow ovary in Kashi Pitamber, cylindrical fruit shape in longitudinal section in Charleston Grey, white seed coat in Durgapur Kesar was observed as distinct trait.

Ene *et al.* (2016) evaluated 16 cucumber genotypes and reported that Beit Alpha genotype gave the highest fruit yield per hectare in early season planting. While in the late season Ashley gave the highest yield. Highest number of branches was observed in Beit Alpha, 'Sumter' gave the highest number of leaves and highest leaf area. Based on high fruit yield, 'Beit Alpha' genotype for early season planting and 'Ashley' genotype for late season are recommended.

Sudhakara and Manchali (2016) characterized twenty-eight landraces of muskmelon using PPV&FRA DUS guidelines. Growth performance results showed that the highest leaf blade length was recorded in COHB-006 followed by COHB-001 and highest leaf blade width was recorded in COHB-038 followed by COHB-019. Significant difference with respect to petiole length was also observed and COHB-019 recorded maximum petiole length followed by COHB-001. Highest ovary length and width was recorded in COHB-002, COHB-032, COHB-034, COHB-037 and COHB-012, respectively. Highest fruit weight was recorded in COHB-034. Genotype COHB-002 produced longest fruits.

Vital *et al.* (2016) evaluated different genotypes of bottle gourd and reported that the genotype Shivani Selection possess maximum vine length, number of primary branches vine⁻¹, number of leaves vine⁻¹ at 30 and 60 DAS, maximum number of fruits vine⁻¹, higher fruit yield plot⁻¹ and hectare⁻¹. The genotype F₁ hybrid BGT-060 was noted for earliness to male and female flowering, Pusa Naveen was noted for minimum number of nodes to first appearance of male and female flower. The genotype Bottle gourd-111 was found to be promising for lower sex ratio (male/female) and maximum fruit length. Maximum average fruit weight was noted in Pusa Naveen. Performance studies revealed that the genotypes Shivani Selection, Pusa Naveen, Bottle gourd- 110, Kashi Ganga and Jabalpur Local were found promising for fruit yield.

3. MATERIAL AND METHODS

The research entitled as “Morphological characterization of cucumber genotypes for improvement of local cultivar (*Cucumis sativus* L.)” was carried out with an objective to study, genetic variability for growth, yield and quality parameters, and their association in cucumber genotypes and characterization of cucumber genotypes based on DUS test guidelines with the following procedure. The materials used and techniques adopted during the course of study are presented in this chapter.

3.1 Experimental site

The experiment was carried out in vegetable science field unit of Kittur Rani Channamma College of Horticulture, Arabhavi, Belgaum (D), Karnataka during 2017-18.

3.2 Location and climate

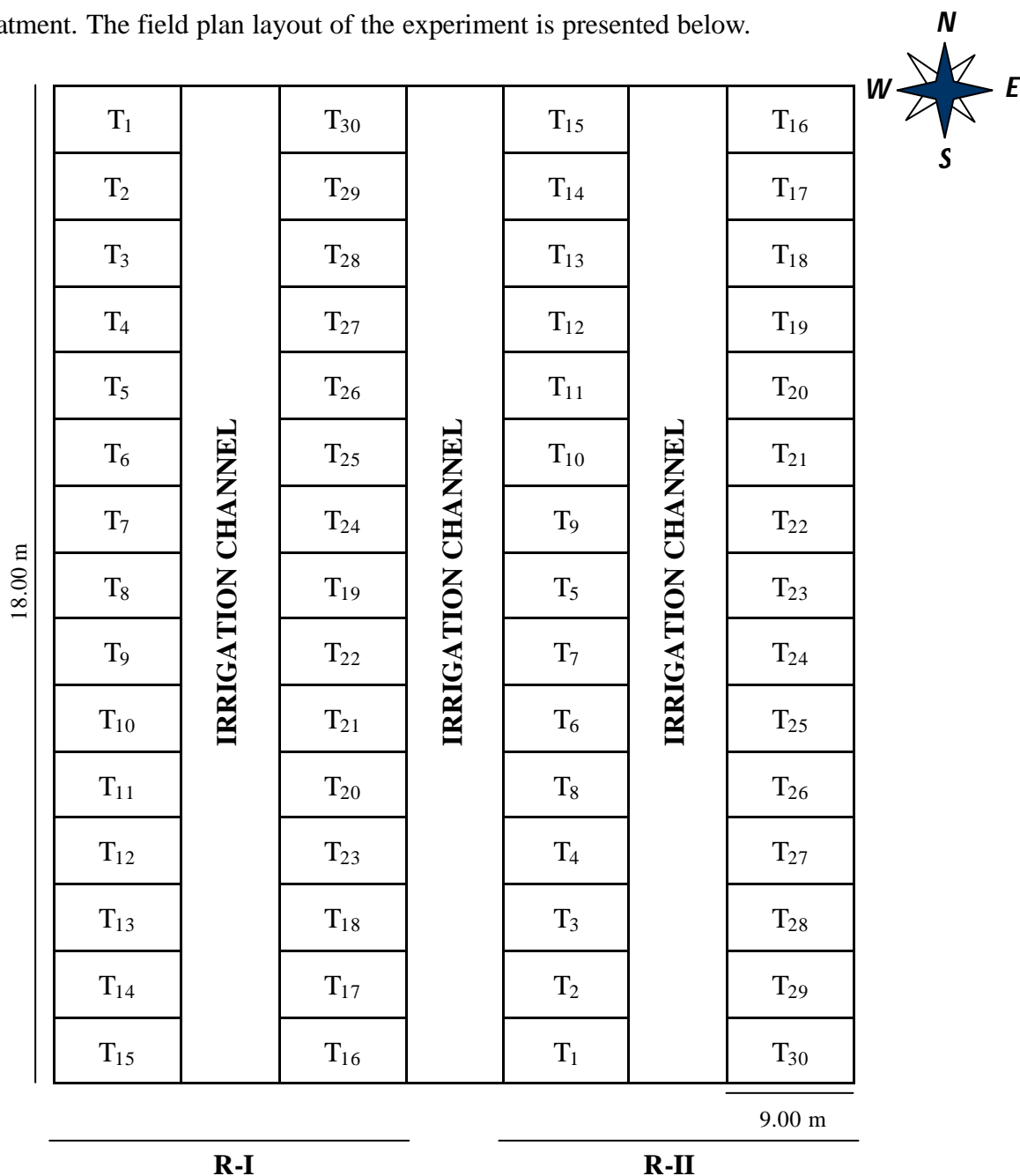
The college is situated at Arabhavi, which comes under zone 3 of region-2 among the agro-climatic zones of Karnataka state. It is situated in northern dry zone of Karnataka state at 16^o 15 North latitude, 75^o 54 East latitude and an altitude of 640 metres above mean sea level. It has benefit of both South-West and North-East monsoons. The rainfall is distributed over a period of five to six months, with an average rainfall of 566 mm. The command areas receive water from Ghataprabha left bank canal (GLBC) from mid-July to mid-March. The meteorological data recorded during experimental observatory of ARS Arabhavi is presented in Appendix I.

3.3 Details of the experiment

Experiment design	: Randomized Block Design (RBD).
Treatment	: 30
Replication	: 2
Spacing	: 1.2 x 0.9 m
Seasons	: <i>Kharif</i> and <i>rabi</i>
Net experimental area	: 648 m ²

3.3.2 Layout of the experiment

The experiment was laid out in randomized complete block design (RCBD) with two replications and 30 genotypes (Table 1), each genotype is considered as one treatment. The field plan layout of the experiment is presented below.



3.3.3 Cultural practices

The experimental plot was ploughed repeatedly and harrowed to remove weeds and crush the clods to bring soil to a fine tilth. FYM of 25 tons per hectare and recommended basal dose of fertilizers were incorporated into the soil (50% of N and full dose of P and K) just before the sowing. Ridges and furrows are opened at a

Table 1: Details of the cucumber genotypes used in the experiment

Sl.no.	Genotypes	Source
1	HUB-1	K.R.C.C.H, Arabhavi
2	HUB-2	K.R.C.C.H, Arabhavi
3	HUB-3	K.R.C.C.H, Arabhavi
4	HUB-4	K.R.C.C.H, Arabhavi
5	HUB-5	K.R.C.C.H, Arabhavi
6	HUB-6	K.R.C.C.H, Arabhavi
7	HUB-7	K.R.C.C.H, Arabhavi
8	HUB-8	Local collation
9	HUB-9	Local collation
10	HUB-10	K.R.C.C.H, Arabhavi
11	Long White	K.R.C.C.H, Arabhavi
12	HUB-11	Local collation
13	HUB-12	Local collation
14	Long Green	K.R.C.C.H, Arabhavi
15	HUB-13	Local collation
16	HUB-14	Local collation
17	HUB-15	Local collation
18	HUB-16	Local collation
19	HUB-17	Local collation
20	HUB-18	Local collation
21	HUB-19	Local collation
22	Poona Khira	Local collation (Poona region)
23	HUB-20	Local collation
24	HUB-21	Local collation
25	HUB-22	Local collation
26	Poinsett	IARI, New Delhi
27	IIHR-264	IIHR, Bangalore
28	IIHR-266	IIHR, Bangalore
29	IIHR-285	IIHR, Bangalore
30	IIHR-303	IIHR, Bangalore



Plate 1: General view of the experimental plot

spacing of 1.2 m. Seeds of each genotype were sown at a spacing of 0.9 m in a row. The remaining 50 percent of nitrogenous fertilizer was top dressed thirty days after sowing. Irrigation, weed control, spraying and other cultural practices were followed as per the package of practices of UHS, Bagalkot (Anon. 2013b).

The vines were allowed to trail on the ground and thinning is done 30 days after sowing to retain one plant per hill. The recommended plant protection measure was taken against insect pests and diseases like fruit fly, leaf miner, powdery mildew, downy mildew with suitable insecticides and fungicides.

3.4 Observations recorded

The observations were recorded for various growth parameters, vegetative, flowering traits at their respective stages and yield parameters were recorded at the time of harvest, from five randomly selected plants in each replication and their mean was taken for analysis. The characters studied and techniques adopted to record the observations are given below.

3.4.1 Growth parameters

3.4.1.1 Vine length (cm)

The length of the vine was recorded from the cotyledonary node to the vine tip after the final harvest and expressed in centimeters.

3.4.1.2 Number of leaves per vine at 90 DAS

The number of leaves were counted at 90 days after sowing and the average was recorded.

3.4.1.3 Leaf area (cm²)

Five plants in each plot were uprooted and used for estimation of leaf area with the help of digital leaf area meter.

3.4.1.4 Internodal length (cm)

The length between one node to another node on the main vine was measured for five plants and the average was recorded during the final harvest.

3.4.1.5 Number of branches per vine at 75 DAS

Total number of primary branches arising from the main axis were recorded at 75 days after sowing.

3.4.2 Earliness parameters

3.4.2.1 Days to first male flower

The number of days taken from date of sowing to the onset of first male flower on the vine was recorded for five plants and the average was taken.

3.4.2.2 Days to first female flower

The number of days taken from date of sowing to the onset of first female flower on the vine was recorded for five plants and the average was taken.

3.4.2.3 Node of first male flower appearance

The node number from the cotyledonous leaves at which the first male flower appeared was recorded for five plants and the average was taken.

3.4.2.4 Node of first female flower appearance

The node number from the cotyledonous leaves at which the first female flower appeared was recorded for five plants and the average was taken.

3.4.2.5 Numbers of male flowers per vine

Total number of male flowers on five randomly selected vines were counted and recorded.

3.4.2.6 Number of female flowers per vine

Total number of female flowers on five randomly selected vines were counted and recorded.

3.4.3 Yield and Yield component

3.4.3.1 Sex ratio (male: female)

Total number of female and male flowers was counted and observation recorded at peak period of flowering. Then, the ratio of female to male flowers was calculated.

$$\text{Sex ratio} = \text{Number of male flowers} / \text{Number of female flowers}$$

3.4.3.2 Fruit setting per cent

Number of flowers produced was recorded on selected plants and subsequently the fruit set was counted and expressed in per cent.

3.4.3.3 Number of fruits per vine

The total number of fruits of all harvests was recorded for five plants and the average was taken.

3.4.3.4 Average fruit weight (g)

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

3.4.3.5 Fruit length (cm)

Length of five fruits harvested at edible maturity was recorded from base to the apex of fruit and averaged.

3.4.3.6 Circumference of fruit (cm)

Circumference of the same five fruits selected for recording the length, was measured in centimetre at maximum thickness with the help of measuring tape.

3.4.3.7 Fruit yield per vine (kg)

The total weight of all marketable fruits obtained per vine was recorded for five plants and the average was expressed in kilograms.

3.4.3.8 Fruit yield per plot (kg)

The fruit yield per plot was computed by summing up all the harvested fruits of each treatment.

3.4.3.9 Fruit yield per hectare (q)

The fruit yield per hectare was worked out based on the fruit weight per net plot.

3.4.4 Fruit quality parameters

3.4.4.1 Fruit colour

Colour of the fruits were recorded at marketable maturity stage and graded into dark green, medium green and light green.

3.4.4.2 Flesh thickness (mm)

Randomly selected five fruits from each treatment were cut into pieces and flesh thickness without the skin was measured and recorded.

3.4.4.3 Hairiness

Recorded by visual assessment by a single observation of a group of fruits.

3.4.4.4 Cavity thickness (mm)

Randomly selected five fruits from each treatment were cut into pieces and cavity thickness was measured using Vernier calliper and recorded.

3.4.4.5 Number of locules

Randomly selected five fruits from each treatment were cut into pieces and number of locules in the cavity were counted and recorded.

3.4.4.6 Vitamin C – content

The ascorbic acid content in the fruit was determined by the volumetric method as suggested by Sadasivam and Manickam (2009) using 2,6-dichloro phenol-indophenol dye.

Dye solution

42 mg of sodium bicarbonate was weighed into a 200 ml volumetric flask in distilled water and 52 mg of 2-6 dichlorophenol indophenol was dissolved in it and then the volume was made up with distilled water.

Standard stock solution

Stock solution was prepared by dissolving 100 mg ascorbic acid in 100 ml of 4 percent oxalic acid solution. 10 ml of stock solution was diluted to 100 ml with 4 percent oxalic acid to get the working standard of 100 mg/ml.

Procedure

Five ml of the working standard solution was pipetted into a 100 ml of conical flask to which 10 ml of 4 percent oxalic acid was added. The contents were titrated against the dye (V_1 ml) to get a pink end point which persisted for a few minutes. The cucumber sample (5 g) was extracted in 4 percent oxalic acid and the volume was made up to 100 ml and the contents were centrifuged. 5 ml of this supernatant was pipetted out, to which 10 ml of 4 per cent oxalic acid was added and titrated against the dye (V_2 ml). The ascorbic acid content was calculated by using the formula as given below.

$$\frac{0.5 \text{ mg}}{V_1} \times \frac{V_2}{5 \text{ ml}} \times \frac{100 \text{ ml}}{\text{Weight of the sample}} \times 100$$

3.4.4.7 Total soluble solids ($^{\circ}$ Brix)

Freshly harvested cucumber fruits were ground with a pestle and mortar to extract the juice and total soluble solid content was recorded in ($^{\circ}$ Brix) with the help of digital refractometer.

3.4.5 Pest and disease incidence

3.4.5.1 Fruit fly infestation (%)

The number of fruits infested with fruit fly was counted at each harvest. fruits number over all the harvests were added to get total and infested fruits per plot, per cent incidence of fruit fly was computed by using following formula (Babu, 2002).

$$\text{Fruit fly incidence} = \frac{\text{Number of fruits infested}}{\text{Total number of fruits}} \times 100$$

Per cent incidence of fruit fly	Reaction categories
0 - 10	Resistant
11 - 25	Moderately resistant
26 - 50	Moderately susceptible
51 - 75	Susceptible
> 75	Highly susceptible

3.4.5.2 Downey mildew incidence

The per cent downy mildew incidence was recorded as per leaf area infested for the genotypes which were scored following zero to five disease rating scale (Girisha, 1989) as given below.

Sl. No.	Percent leaf area infested	Score	Reaction category
1	0	0	Immune
2	1 -10	1	Resistant
3	11 – 25	2	Moderately Resistant
4	26 – 50	3	Moderately susceptible
5	51 – 75	4	Susceptible
6	76 -100	5	Highly susceptible

3.4.5.3 Powdery mildew incidence

The per cent powdery mildew incidence was recorded as per leaf area infested for which genotypes were scored from zero to nine disease rating scale (Wheeler 1969) as given below.

Percent infestation	Description	Score
0	No symptom of powdery mildew	0
1 -10	Small scattered powdery specks	1
11 – 25	Small powdery lesions covering leaf	3
26 – 50	Enlarged powdery lesions covering leaf	5
51 – 75	Powdery lesions coalesce to form big patches	7
76 -100	Big powdery patches covering large leaf area and defoliation of leaf	9

3.4.5.4 Anthracnose

The intensity of anthracnose disease under natural conditions was assessed by scoring the genotypes following zero to five scale (Pan and More, 1996) as detailed below.

Score	Disease incidence	Reaction
0	No symptom	Immune
1	Less than 10 isolated spots	Resistant
2	10-20 isolated spots	Moderately resistant
3	More than 20 spots + necrotic patches more than 30 per cent but less than 50 per cent leaf area affected	Moderately susceptible
4	Necrotic patches, 50 per cent leaf area affected	Susceptible
5	Necrotic patches, more than 50 per cent leaf area affected	Highly susceptible

3.5 Statistical and biometrical analysis

3.5.1 Analysis of variance (ANOVA)

Analysis of variance was carried out as per the model described by Panse and Sukhatme (1961) using the mean values of random plants in each replication from all the treatments to find out significance of the treatment effect.

The model of analysis of variance is given below.

Source	D. F	SS	MSS	Cal. F
Replication	r-1	RSS	RSS/(r-1)	TMSS/ EMSS
Treatments	t-1	TSS	TSS/(t-1)	-
Error	(r-1)(t-1)	ESS	ESS/(r-1)(t-1)	-
Total	(rt-1)	-	-	-

Where,

t = Number of treatments (Genotypes)

r = Number of replications

Standard error was calculated as,

$$SEm \pm = \frac{\sqrt{EMSS}}{r}$$

The significance of treatments, mean square and replication mean square were tested by comparing with error mean squares referring to 'F' table values at 5 and 1 per cent level of probabilities.

3.5.2 Estimation of genetic variability parameters

3.5.2.1 Phenotypic and Genotypic Variance

The phenotypic and genotypic variance were estimated according to the method suggested by Comstock and Robinson (1952).

$$\text{Genotypic variance (s } g^2) = \frac{M_v - M_e}{r}$$

$$\text{Phenotypic variance (s } p^2) = s g^2 + s e^2$$

M_v = Mean squares due to genotype

M_e = Mean squares due to error

r = Number of replication

$s e^2$ = Environmental variance

3.5.2.2 Phenotypic and Genotypic coefficient of variation (PCV) and (GCV)

Phenotypic and Genotypic coefficient of variation were calculated by using formula suggested by Burton and Devane (1953).

$$\text{Phenotypic coefficient of variation (PCV) (\%)} = \frac{\text{Phenotypic variance}}{\text{General mean}} \times 100$$

$$\text{Genotypic coefficient of variation (GCV) (\%)} = \frac{\text{Genotypic variance}}{\text{General mean}} \times 100$$

GCV and PCV were classified as suggested by Burton and Devane (1953)

0-10% : Low

10- 20% : Moderate

20% and above : High

3.5.2.3 Heritability (Broad sense)

Heritability in the broad sense refers to the proportion of genotypic variance to the total variance observed in the population. It was calculated according to the formula given by Webber and Moorthy (1952).

$$\text{Heritability (h}^2\text{)} = \frac{\text{Genotypic variance (s}^2\text{g)}}{\text{Phenotypic variance (s}^2\text{p)}} \times 100$$

As suggested by Johnson *et al.* (1955), heritability estimates were categorized as,

Low	: 0-30%
Medium	: 30-60%
High	: 61 % and above

3.5.2.4 Genetic Advance (GA)

Genetic Advance was estimated as per the formula proposed by Johnson *et al.* (1955).

$$\text{GA} = h^2 \times s_p \times k$$

Where,

k = Selection differential (2.06) at 5 percent selection intensity.

h^2 = Heritability in broad sense

s_p = Phenotypic standard deviation

3.5.2.5 Genetic advance over per cent of mean (GAM)

Genetic advance over per cent of mean was found out by the formula proposed by Johnson *et al.* (1955).

$$\text{Genetic advance over mean (GAM)} = \frac{\text{GA}}{\bar{X}} \times 100$$

Where,

GA = Genetic advance

\bar{X} = General mean

Genetic advance over per cent of mean was categorized as suggested by Johnson *et al.* (1955) as given below.

0-10%	: Low
11-20%	: Moderate
21% and above	: High

3.5.3 Genetic divergence

The data collected on different characters were analysed through Mahalanobis's D^2 statistics.

3.5.3.1 Mahalanobis's D^2 analysis (1936)

The genetic divergence between the genotypes in the population was estimated using the following formula.

The D^2 value between i^{th} and j^{th} genotypes for p characters was calculated as

$$D^2 = p (Y_{it} - Y_{jt})$$

Y_{it} = Uncorrected mean value of i^{th} genotype for t^{th} character

Y_{jt} = Uncorrected mean value of j^{th} genotype for t^{th} character

D^2_{ij} = D^2 value between i^{th} and j^{th} genotype

Transformation of correlated variables into standardised uncorrelated values was done before working out the D^2 values to simplify the computation of values. The D^2 values were obtained as the sum of square of the differences between the pair of corresponding uncorrelated (Ys) values of any two genotypes.

A total of $\frac{n(n-1)}{2} D^2$ values were calculated.

Where, n = Number of genotypes.

3.5.3.2 Clustering of genotypes

Using all D^2 values, the genotypes were grouped into clusters using Tocher's method as described by Rao (1952).

3.5.3.3 Intra- and Inter-cluster distances

The intra and inter clustering distances were calculated by the formula given by Singh and Chaudhary (1979).

$$\text{Square of intra cluster distance} = \frac{SDi^2}{n}$$

Where,

Di^2 = Sum of D^2 values between all possible combinations of the genotypes included in cluster.

n = Number of genotypes in cluster

$$\text{Square of inter cluster distance} = \frac{SDij^2}{ninj}$$

Where,

Dij^2 = Sum of distance between all possible combinations ($ninj$) of the two clusters.

ni = Number of genotypes in cluster 'i'

nj = Number of genotypes in cluster 'j'.

3.5.4 Correlation analysis

The correlation coefficient among all possible character combinations at phenotypic (r_p) and genotypic (r_g) level were estimated employing formula (Al-Jibouri *et al.* 1958).

$$\text{Phenotypic correlation} = r_{xy}(p) = \frac{\text{Cov}_{xy}(p)}{\sqrt{V_x(p) \times V_y(p)}}$$

$$\text{Genotypic correlation} = r_{xy}(g) = \frac{\text{Cov}_{xy}(g)}{\sqrt{V_x(g) \times V_y(g)}}$$

Where,

$\text{Cov}_{xy}(p)$ = Phenotypic variance between x and y

$\text{Cov}_{xy}(g)$ = Genotypic variance between x and y

$V_x(p)$ = Phenotypic variance of character 'x'

$V_x(g)$ = Genotypic variance of character 'x'

$V_y(p)$ = Phenotypic variance of character 'y'

$V_y(g)$ = Genotypic variance of character 'y'

Significance test for association between characters was done by comparing table 'r' values at n-2 error degrees of freedom for both phenotypic and genotypic correlation with their estimated values.

3.5.5 Path co-efficient analysis

The path coefficient analysis was carried out by the method suggested by Dewey and Lu (1959). The genotypic and phenotypic correlation coefficients were used in finding out the direct and indirect effects of the morphological traits on the plant yield. The following set of simultaneous equations were formed and solved for estimating various direct and indirect effect.

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

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

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

$$r_{1y} = r_{11}a + r_{12}b + r_{13}c + \dots + I$$

Where,

r_{1y} to r_{11} = Co-efficient of correlation between casual factors 1 to I with dependent character y.

r_{12} to r_{11} = Co-efficient of correlation among casual factors

a, b, ci = Direct effect of character 'a' to 'I' on the dependent characters y.

Residual effect (R) was computed as followed,

$$\text{Residual effect (R)} = 1 - \sqrt{\frac{a^2 + b^2 + c^2 + \dots + i^2 + 2abr_{12} + 2acr_{13} + \dots}{v}}$$

3.6 Varietal characterization of cucumber genotypes based on DUS guidelines

The genotypes used for the studying of variability were also used for the varietal characterization based on DUS test guidelines. The layout and cultural practices were followed as mentioned in 3.3.

3.6.1 Observations recorded

3.6.1.1 Plant growth habit

Plant growth habit is recorded as 1-determinate, 2-intermediate and 3-indeterminate by visual assessment by a single observation of a group of plants or parts of plants.

3.6.1.2 Main vine length

Vine length is measured and recorded as 1-short (<1.25 m), 2-intermediate (1.25 - 2.0 m) and 3-long (>2.0 m).

3.6.1.3 Leaf blade orientation

Leaf blade orientation is visual assessed by a single observation of a group of plants or parts of plants and recorded as 1-erect, 2-horizontal and 3-drooping.

3.6.1.4 Leaf blade length

Leaf blade length is measured and recorded as 3-short (<14 cm), 5-intermediate (14 – 20 cm) and 7-long (>20 cm).

3.6.1.5 Stem pubescence

Stem pubescence is recorded as 1-absent or 9-present at 30 days after sowing by visual observation of a group of plants.

3.6.1.6 Stem shape

Stem shape is visually assessed by a single observation of a group of plants or parts of plants at 30 days after sowing and recorded as 1-angular or 2-rounded.

3.6.1.7 Appearance of first pistillate flower in 50 percent plant

Number of days taken from the date of sowing to the day when 50 per cent female flowering were counted and recorded as 3-early, 5-medium and 7-late.

3.6.1.8 Plant sex expression

Plant sex expression is visually assessed by a single observation of a group of plants or parts of plants at 30 days after sowing was recorded as 1-monoecious or 9-gynoecious.

3.6.1.9 Ovary colour of vestiture

Ovary colour of vestiture is recorded as 1-white or 2-black at 30 days after sowing by visual assessment by a single observation of a group of plants.

3.6.1.10 Parthenocarpy

Parthenocarpy is recorded as 1-absent or 9-present at 40 days after sowing by visual observation of a group of plants.

3.6.1.11 Fruit length

Length of five fruits harvested at edible maturity was recorded from base to the apex of fruit and grouped as 3-short (<15 cm), 5-medium (15 cm - 25 cm) and 7-long (>25 cm).

3.6.1.12 Fruit diameter

Diameter of the same five fruits selected for recording the length was measured in centimetre at maximum thickness with the help of vernier calliper and recorded as 3-small, 5-medium and 7-large.

3.6.1.13 Fruit shape

Fruit shape is recorded as 1-elongate, 2-blong, 3-cylindrical or 4-oval by visual assessment by a single observation of a group of plants or parts of plants.

3.6.1.14 Fruit shape at peduncle end

It is observed and categorised as three different classes 1-flat, 2-acute and 3-obtuse after visually observing the group of fruits.

3.6.1.15 Fruit colour of skin at market stage

Skin colour is visually assessed at marketable fruit maturity stage and categorized as 1-creamy white, 2-yellow, 3-light green and 4-dark green.

3.6.1.16 Fruit ribs

Presence-9 or absence-1 of ribs on fruits is visually assessed by observing number of fruits and recorded.

3.6.1.17 Fruit creasing

Presence-9 or absence-1 of lines or wrinkle on fruits is visually assessed by observing number of fruits and recorded.

3.6.1.18 Fruit type of vestiture hair

Type of vestiture hair is visually assessed by a single observation of a group of fruits at edible maturity and recorded as 3-hairy, 5-non-hairy or 7-prickles.

3.6.1.19 Fruit density of vestiture

Density of vestiture visually assessed by a single observation of a group of fruits at edible maturity and recorded as 3-sparse, 5-medium or 7-dense.

3.6.1.20 Seed size

Seed size is measured on fully developed and dry seed and categorized as 3-small (<1.00 cm), 5-medium (1.00-1.20 cm) and 7-large (>1.20 cm).

3.6.1.21 Seediness (Number of seeds/fruit)

Seediness is recorded after counting fully developed and dry seed, after washing and drying in the shade and recorded as 3-low, 5-medium and 7-high.

4. EXPERIMENTAL RESULTS

A field experiment comprises of 30 cucumber genotypes was laid out in a randomized complete block design with all recommended package of practices during 2017-18. Extent of genetic variability for morphological and quality parameters, path analysis and correlation between yield and yield components, genetic diversity of genotypes based on yield and yield components was studied. The results obtained from the present investigation are present over the following headings.

4.1 Genetic variability

4.2 Genetic diversity

4.3 Character association

4.4 Path analysis

4.1 Genetic variability

4.1.1 Analysis of variance

Analysis of variance was calculated to test the significant difference among the 30 genotypes. Values of replication, treatment and error mean sum of square and critical difference at 5 per cent level of significance is presented in the Table 2, 3 and 4. The result from analysis of variance revealed significant difference for growth, earliness, yield and quality parameters studied among genotypes for all the characters.

4.1.2 Genetic variability

Mean, range, phenotypic variance (PV), genotypic variance (GV), phenotypic co-efficient of variation (PCV), genotypic co-efficient of variation (GCV), heritability (h^2), genetic advance (GA) and genetic advance as per cent of mean (GAM) for 24 traits (Significant treatment variance) are presented in Table 5, 6 and 7. PCV is higher than GCV in all the traits studied indicates the influence of environment on the cucumber genotype. The mean performance of the genotypes for various characters is presented in Appendix II.

Table 2. Analysis of variance (mean sum of square) for growth, earliness, yield and quality parameters in cucumber (*Kharif* season) 2017-18

Sl. No.	Sources of variation/ characters	Repl ication	Genotypes	Error	SEm±	CD (5%)
	Degrees of freedom	1	29	29		
A	Growth parameters					
1	Vine length (cm)	0.0166	1518.86**	45.00	4.66	13.71
2	Number of leaves at 90 DAS	101.66	649.02**	27.51	3.64	10.72
3	Leaf area (cm ²)	183.57	12112.12**	164.81	8.92	26.25
4	Internodal length (cm)	0.004	8.498**	0.309	0.38	1.13
5	Number of branches per vine at 75 DAS	0.192	1.518**	0.093	0.21	0.62
B	Earliness parameters					
6	Days to first male flowering	11.39	24.011**	1.526	0.85	2.52
7	Days to first female flowering	113.98	12.20**	3.110	1.22	3.60
8	Node of first male flower appearance	0.035	0.423**	0.092	0.21	0.622
9	Node of first female flower appearance	0.008	0.411**	0.111	0.23	0.68
10	Number of male flowers per vine	10.25	439.89**	16.85	2.85	8.39
11	Number of female flowers per vine	0.912	9.913**	0.875	0.65	1.91
C	Yield and yield attributing parameters					
12	Sex ratio	0.539	2.725**	0.242	0.34	1.007
13	Fruit setting per cent	35.08	98.96**	13.84	2.58	7.61
14	Number of fruits per vine	0.130	1.586**	0.172	0.28	0.84
15	Average fruit weight (g)	39.69	3108.13**	79.40	6.19	18.22
16	Fruit length (cm)	0.117	22.63**	0.796	0.62	1.82
17	Circumference of fruit (cm)	0.712	2.755**	0.438	0.46	1.35
18	Fruit yield per vine (kg)	0.0003	0.105**	0.009	0.068	0.20
19	Fruit yield per plot (kg)	0.045	10.57**	0.942	0.67	1.98
20	Fruit yield per hectare (q)	3.92	906.51**	80.81	6.36	18.39
D	Fruit quality parameters					
21	Flesh thickness (mm)	4.782	13.26**	0.946	0.67	1.99
22	Cavity thickness (mm)	4.532	5.246**	0.805	0.89	1.83
23	Vitamin- C content (mg/100g)	0.0004	0.350**	0.050	0.15	0.45
24	Total soluble solids (^o Brix)	0.0008	0.090**	0.0116	0.07	0.22

** significant at 1% probability

Table 3. Analysis of variance (mean sum of square) for growth, earliness, yield and quality parameters in cucumber (*Rabi* season)

Sl. No.	Sources of variation/ characters	Repli cation	Genotypes	Error	SEm±	CD (5%)
	Degrees of freedom	1	29	29		
A	Growth parameters					
1	Vine length (cm)	3.128	1792.03**	34.53	4.08	12.01
2	Number of leaves at 90 DAS	15.40	783.45**	28.08	3.68	10.83
3	Leaf area (cm ²)	335.79	11729.03**	158.96	8.76	25.78
4	Internodal length (cm)	1.241	7.092**	0.239	0.34	1.0003
5	Number of branches per vine at 75 DAS	0.121	1.379**	0.115	0.23	0.69
B	Earliness parameters					
6	Days to first male flowering	34.96	7.844*	3.885	1.37	4.03
7	Days to first female flowering	49.50	11.58**	2.145	1.01	2.99
8	Node of first male flower appearance	0.039	0.326**	0.1004	0.22	0.64
9	Node of first female flower appearance	0.308	0.415**	0.084	0.20	0.59
10	Number of male flowers per vine	4.930	423.10**	14.85	2.67	7.88
11	Number of female flowers per vine	0.216	8.044**	1.125	0.73	2.16
C	Yield and yield attributing parameters					
12	Sex ratio	0.282	4.429**	0.545	0.51	1.51
13	Fruit setting per cent	42.92	104.38**	26.12	3.55	10.45
14	Number of fruits per vine	0.322	3.260**	0.239	0.34	1.001
15	Average fruit weight (g)	0.144	3688.5**	100.87	6.98	20.54
16	Fruit length (cm)	1.444	24.43**	0.993	0.69	2.03
17	Fruit diameter (cm)	0.726	2.488**	0.621	0.54	1.61
18	Fruit yield per vine (kg)	0.004	0.189**	0.009	0.06	0.19
19	Fruit yield per plot (kg)	0.473	18.98**	0.905	0.66	1.94
20	Fruit yield per hectare (q)	40.41	1627.57**	77.56	6.23	18.01
D	Fruit quality parameters					
21	Flesh thickness (mm)	0.106	13.82**	1.008	0.69	2.05
22	Cavity thickness (mm)	2.735	8.205**	1.951	0.97	2.85
23	Vitamin- C content (mg/100g)	0.007	0.730**	0.112	0.23	0.68
24	Total soluble solids (^o Brix)	0.010	0.143**	0.023	0.10	0.31

** significant at 1% probability

Table 4. Analysis of variance (mean sum of square) for growth, earliness, yield and quality parameters in cucumber (Pooled average over both the seasons) 2017-18

Sl. No.	Sources of variation/ characters	Repli- cation	Genotypes	Error	SEm±	CD (5%)
	Degrees of freedom	1	29	29		
A	Growth parameters					
1	Vine length (cm)	0.392	1572.45**	16.39	2.81	8.28
2	Number of leaves at 90 DAS	9.48	701.41**	14.30	2.62	7.73
3	Leaf area (cm ²)	5.70	11888.91**	85.60	6.43	18.92
4	Internodal length (cm)	0.276	7.662**	0.159	0.27	0.81
5	Number of branches per vine at 75 DAS	0.002	1.28**	0.049	0.15	0.45
B	Earliness parameters					
6	Days to first male flowering	21.57	13.15**	1.487	0.84	2.49
7	Days to first female flowering	78.43	10.057**	1.566	0.87	2.55
8	Node of first male flower appearance	0.036	0.351**	0.058	0.16	0.49
9	Node of first female flower appearance	0.054	0.370**	0.056	0.16	0.48
10	Number of male flowers per vine	0.240	423.33**	8.014	1.96	5.79
11	Number of female flowers per vine	0.060	8.049**	0.494	0.48	1.43
C	Yield and yield attributing parameters					
12	Sex ratio	0.010	3.245**	0.205	0.31	0.92
13	Fruit setting per cent	0.098	79.48**	8.78	2.06	6.06
14	Number of fruits per vine	0.010	2.096**	0.092	0.21	0.62
15	Average fruit weight (g)	11.15	3356.77**	57.64	5.27	15.52
16	Fruit length (cm)	0.182	22.86**	0.479	0.48	1.41
17	Fruit diameter (cm)	0.719	2.374**	0.222	0.32	0.96
18	Fruit yield per vine (kg)	0.0006	0.137**	0.005	0.05	0.15
19	Fruit yield per plot (kg)	0.055	13.78**	0.547	0.51	1.51
20	Fruit yield per hectare (q)	4.76	1181.57**	47.03	4.85	14.03
D	Fruit quality parameters					
21	Flesh thickness (mm)	1.564	12.50**	0.500	0.49	1.44
22	Cavity thickness (mm)	3.601	6.303**	0.684	0.57	1.69
23	Vitamin- C content (mg/100g)	0.002	0.496**	0.037	0.13	0.39
24	Total soluble solids (⁰ Brix)	0.001	0.110**	0.013	0.07	0.23

** Significant at 1% probability

Table 5. Estimates of genetic parameters for different traits in cucumber for *kharif* season

Sl. No.	Character	Range	Mean	PCV (%)	GCV (%)	h^2 (%)	GA	GAM (%)
A	Growth parameters							
1	Vine length (cm)	115.95-219.00	150.52	18.57	18.03	94.24	54.28	36.06
2	Number of leaves at 90 DAS	50.0-118.65	81.54	22.55	21.61	91.87	34.80	42.68
3	Leaf area (cm ²)	79.50-337.78	190.45	41.13	40.58	97.32	157.06	82.46
4	Internodal length (cm)	4.23-12.20	6.66	31.49	30.37	92.97	4.01	60.32
5	Number of branches per vine at 75 DAS	1.95-5.75	3.89	23.07	21.69	64.04	1.63	42.03
B	Earliness parameters							
6	Days to first male flowering	29.70-41.20	35.85	9.96	9.35	88.05	6.48	18.07
7	Days to first female flowering	36.60-47.10	41.38	6.68	5.15	59.38	3.38	8.17
8	Node of first male flower appearance	2.1-3.8	2.93	17.33	13.88	64.18	0.67	22.92
9	Node of first female flower appearance	3.9-5.6	4.70	10.85	8.22	60.47	0.60	12.84
10	Number of male flowers per vine	62.5-115.50	93.82	16.10	15.50	92.62	28.83	30.73
11	Number of female flowers per vine	10.25-17.90	14.05	16.53	15.13	83.78	4.008	28.52

Contd.....

Sl. No.	character	Range	Mean	GCV (%)	PCV (%)	h^2 (%)	GA	GAM (%)
C	Yield and yield attributing parameters							
12	Sex ratio	4.5-9.08	6.80	17.89	16.36	83.66	2.09	30.83
13	Fruit setting per cent	29.60-52.98	39.24	19.13	16.62	74.45	11.67	29.74
14	Number of fruits per vine	3.65-7.80	5.31	17.00	15.24	80.39	1.55	28.16
15	Average fruit weight (g)	52.85-236.80	154.23	25.88	25.23	95.02	78.14	50.66
16	Fruit length (cm)	4.90-18.75	14.14	24.42	23.57	93.20	6.57	46.88
17	Circumference of fruit (cm)	11.33-15.55	13.44	9.39	8.00	72.56	1.88	14.04
18	Fruit yield per vine (kg)	0.32-1.22	0.82	29.14	26.61	83.44	0.41	50.08
19	Fruit yield per plot (kg)	3.28-12.26	8.24	29.08	26.60	83.63	4.13	50.11
20	Fruit yield per hectare (q)	30.39-113.52	76.39	29.09	26.60	83.63	38.28	50.11
D	Fruit quality parameters							
21	Flesh thickness (mm)	7.65-19.93	14.05	18.95	17.65	86.67	4.75	33.85
22	Cavity thickness (mm)	18.27-26.62	23.76	7.31	6.26	73.39	2.62	11.06
23	Vitamin- C content (mg/100g)	2.10-3.80	2.89	15.49	13.41	74.87	0.69	23.90
24	Total soluble solids (^o Brix)	2.15-3.15	2.56	8.81	7.73	77.11	0.35	13.99

GCV = Genotypic coefficient of variation h^2 = Heritability (Broad Sense) GAM= Genetic advance (percent mean)
PCV = Phenotypic coefficient of variation GA = Expected genetic advance

Table 6. Estimates of genetic parameters for different traits in cucumber for *Rabi* season

Sl. No.	character	Range	Mean	PCV (%)	GCV (%)	h^2 (%)	GA	GAM (%)
A	Growth parameters							
1	Vine length (cm)	87.55-194.10	129.23	23.38	22.93	96.22	59.90	46.35
2	Number of leaves at 90 DAS	38.45-109.20	68.14	29.56	28.52	93.08	38.62	56.68
3	Leaf area (cm ²)	60.30-314.39	176.96	43.56	42.97	97.33	154.57	87.34
4	Internodal length (cm)	4.63-12.30	6.83	27.99	27.06	93.47	3.68	53.90
5	Number of branches per vine at 75 DAS	1.7-4.6	3.54	24.29	22.40	84.53	1.50	42.43
B	Earliness parameters							
6	Days to first male flowering	36.45-45.10	40.98	5.90	3.43	33.75	1.68	4.10
7	Days to first female flowering	42.75-52.70	47.52	5.51	4.57	68.75	3.71	7.81
8	Node of first male flower appearance	2.5-4.15	3.02	15.25	11.10	52.96	0.50	16.64
9	Node of first female flower appearance	3.80-5.45	4.53	11.01	8.97	66.37	0.68	15.06
10	Number of male flowers per vine	47.0-103.50	79.16	18.69	18.04	93.22	28.41	35.89
11	Number of female flowers per vine	7.65-16.00	11.53	18.57	16.13	75.45	3.32	28.86

Contd.....

Sl. No.	Character	Range	Mean	PCV (%)	GCV (%)	h^2 (%)	GA	GAM (%)
C	Yield and yield attributing parameters							
12	Sex ratio	4.03-10.13	7.02	22.45	19.83	78.05	2.53	36.10
13	Fruit setting per cent	33.06-65.03	50.25	16.07	12.44	59.97	9.97	19.85
14	Number of fruits per vine	2.60-9.15	5.81	22.74	21.12	86.31	2.35	40.43
15	Average fruit weight (g)	53.41-238.35	157.08	27.71	26.96	94.68	84.89	54.04
16	Fruit length (cm)	4.56-19.70	13.70	26.02	24.98	92.19	6.77	49.41
17	Circumference of fruit (cm)	11.25-15.75	13.57	9.18	7.11	60.04	1.54	11.36
18	Fruit yield per vine (kg)	0.33-1.44	0.91	34.59	32.97	90.86	0.59	64.75
19	Fruit yield per plot (kg)	3.28-14.16	9.11	34.59	32.98	90.90	5.90	64.78
20	Fruit yield per hectare (q)	30.37-133.94	84.40	34.60	32.99	90.90	54.68	64.79
D	Fruit quality parameters							
21	Flesh thickness (mm)	8.74-20.30	14.76	18.45	17.15	86.40	4.84	32.84
22	Cavity thickness (mm)	16.68-27.42	23.47	9.59	7.53	61.57	2.85	12.17
23	Vitamin- C content (mg/100g)	2.14-4.49	3.37	19.23	16.47	73.37	0.98	29.06
24	Total soluble solids ($^{\circ}$ Brix)	2.42-3.39	2.78	10.38	8.82	72.31	0.43	15.46

GCV = Genotypic coefficient of variation h^2 = Heritability (Broad Sense) GAM= Genetic advance (per cent mean)
PCV = Phenotypic coefficient of variation GA = Expected genetic advance

Table 7. Estimates of genetic parameters for different traits in cucumber for pooled average over both the seasons

Sl. No.	Character	Range	Mean	PCV (%)	GCV (%)	h^2 (%)	GA	GAM (%)
A	Growth parameters							
1	Vine length (cm)	101.88-204.55	139.83	20.15	19.94	97.9	56.86	40.66
2	Number of leaves at 90 DAS	43.67-112.32	74.84	25.27	24.76	96.00	37.41	49.98
3	Leaf area (cm ²)	69.90-326.09	183.70	42.11	41.81	98.57	157.11	85.52
4	Internodal length (cm)	4.45-12.25	6.75	29.29	28.69	95.9	3.90	57.88
5	Number of branches per vine at 75 DAS	1.87-5.17	3.71	21.93	21.10	92.6	1.55	41.83
B	Earliness parameters							
6	Days to first male flowering	33.42-43.15	38.42	7.04	6.28	79.7	4.44	11.55
7	Days to first female flowering	40.12-49.90	44.45	5.42	4.63	73.1	3.62	8.16
8	Node of first male flower appearance	2.30-3.91	2.97	15.19	12.86	71.6	0.66	22.42
9	Node of first female flower appearance	3.87-5.35	4.62	9.99	8.57	73.6	0.70	15.15
10	Number of male flowers per vine	54.75-106.55	86.49	16.97	16.66	96.3	29.12	33.67
11	Number of female flowers per vine	8.95-16.25	12.79	16.16	15.19	88.4	3.76	29.43

Contd.....

Sl. No.	Character	Range	Mean	GCV (%)	PCV (%)	h^2 (%)	GA	GAM (%)
C	Yield and yield attributing parameters							
12	Sex ratio	4.42-9.60	6.91	18.98	17.82	88.1	2.38	34.46
13	Fruit setting per cent	32.46-58.08	44.75	14.84	13.28	80.09	10.96	24.49
14	Number of fruits per vine	3.20-8.47	5.66	18.46	17.66	91.58	1.97	34.83
15	Average fruit weight (g)	53.13-234.85	155.65	26.54	26.09	96.62	82.24	52.83
16	Fruit length (cm)	4.73-18.45	13.85	24.65	24.14	95.89	6.74	48.70
17	Circumference of fruit (cm)	11.92-15.65	13.51	8.43	7.67	82.89	1.94	14.39
18	Fruit yield per vine (kg)	0.33-1.32	0.86	30.81	29.60	92.31	0.50	58.59
19	Fruit yield per plot (kg)	3.28-13.16	8.68	30.83	29.63	92.36	5.09	58.66
20	Fruit yield per hectare (q)	30.38-121.85	80.39	30.83	29.63	92.34	47.15	58.65
D	Fruit quality parameters							
21	Flesh thickness (mm)	8.42-19.24	14.41	17.69	16.99	92.30	4.84	33.64
22	Cavity thickness (mm)	17.47-26.8	23.62	7.91	7.09	80.40	3.09	13.10
23	Vitamin- C content (mg/100g)	2.20-4.00	3.13	16.49	15.28	85.9	0.91	29.18
24	Total soluble solids ($^{\circ}$ Brix)	2.32-3.24	2.67	9.31	8.28	79.0	40.5	15.16

GCV = Genotypic coefficient of variation h^2 = Heritability (Broad Sense) GAM= Genetic advance (per cent mean)
PCV = Phenotypic coefficient of variation GA = Expected genetic advance

4.1.2.1 Vine length

In *kharif* vine length ranged from 115.95 (HUB 14) to 219 cm (Long Green) with overall mean of 150.52 cm. Moderate PCV (18.57%) and GCV (18.03%), very high heritability (94.24%) along with high GAM (36.06%) were observed for vine length.

In *rabi* vine length ranged from 87.55 (HUB 11) to 194.10 cm (HUB-16) with overall mean of 129.23 cm. High PCV (23.38%) and GCV (22.93%), very high heritability (96.22%) along with very high GAM (46.35%) were noticed for this trait.

In pooled average over mean vine length ranged from 101.88 (HUB 11) to 204.55 cm (HUB-16) with average mean of 139.83 cm. Moderate PCV (20.15%) and GCV (19.94%), very high heritability (97.90%) coupled with very high GAM (40.66%) were observed.

4.1.2.2 Number of leaves per vine at 90 DAS

In *Kharif* season number of leaves per vine ranged from 50 (Long White) to 118.65 (HUB-1) with average mean of 81.54. High PCV (22.55%) and GCV (21.61%), very high heritability (91.87%) along with high GAM (42.68%) were recorded.

In *rabi* season number of leaves per vine ranged from 38.45 (HUB-11) to 109.20 (IIHR-285) with an average mean of 68.14. The estimates of PCV (29.56%) and GCV (28.52%) were high and very high heritability (93.08%) along with very high GAM (56.68%) were noticed.

In pooled average over both the season number of leaves per vine ranged from 46.37 (Long White) to 112.32 (HUB-1) with grand mean of 74.84. High estimates of PCV (25.27%) and GCV (24.76%), very high heritability (96.00%) along with very high GAM (49.98%) were recorded.

4.1.2.3 Leaf area (cm²)

In *kharif* season leaf area ranged from 79.50-337.78 cm² with grand mean of 190.45 cm². Maximum leaf area was recorded in Long Green (337.79 cm²) followed by HUB-22 (328.75 cm²) and HUB-16 (322.45 cm²). Whereas minimum leaf area

was recorded in HUB-14 (79.50 cm²). Very high PCV (41.13%) and GCV (40.58%), associated with very high heritability (97.32%) and GAM (82.46%) were noted for this trait.

In *rabi* season maximum leaf area was recorded in Long Green (314.39 cm²) followed by IIHR-285 (309.80 cm²) and HUB-16 (308.50 cm²). Minimum leaf area was recorded in HUB-14 (60.30 cm²) with grand mean of 176.96 cm². High estimates of PCV (43.56%) and GCV (42.97%), very high heritability (97.33%) along with very high GAM (87.34%) were recorded for this trait.

In pooled average over both the season maximum leaf area was noticed in Long Green (326.09 cm²) followed by HUB-22 (316.81 cm²) and HUB-16 (315.48 cm²). Minimum leaf area was recorded in HUB-14 (69.90 cm²) with grand mean of 183.70 cm². High estimates of PCV (42.11%) and GCV (41.81%), very high heritability (98.57%) along with very high GAM (85.52%) were recorded.

4.1.2.4 Internodal length

In *kharif* season internodal length ranged from 4.22 (HUB-7) to 12.20 cm (Poona Khira) with grand mean of 6.66 cm. Very high estimates of PCV (31.49%) and GCV (30.37%), very high heritability (92.97%) coupled with high GAM (60.32%) were observed for Internodal length.

In *rabi* season internodal length ranged from 4.63 (HUB-2) to 12.30 cm (Poona Khira) with grand mean of 6.83 cm. High estimates of PCV (27.99%) and GCV (27.06%), very high heritability (93.47%) along with high GAM (53.90%) were recorded for this trait.

In pooled average over both the season internodal length ranged from 4.45 (HUB-7) to 12.25 cm (Poona Khira) with grand mean of 6.75 cm. High estimates of PCV (29.29%) and GCV (28.69%), very high heritability (95.9%) along with high GAM (57.88%) were recorded.

4.1.2.5 Number of primary branches per vine at 75 DAS

In *Kharif* season number of primary branches per vine ranged from 1.95 (HUB-16) to 5.75 (HUB-4) with grand mean of 3.89. Estimates of PCV (23.07%) and

GCV (21.69%) were high, with high heritability (64.04) coupled with high GAM (42.03%).

In *rabi* season number of primary branches per vine ranged from 1.7 (HUB-11) to 4.6 (HUB-4) with grand mean of 3.54. High PCV (24.29%) and GCV (22.40%), very high heritability (84.53%) along with high GAM (42.43%) were recorded for this trait.

In pooled average over both the season number of primary branches per vine ranged from 1.87 (HUB-16) to 5.17 (HUB-4) with grand mean of 3.71. Estimates of PCV (21.93%) and GCV (21.10%) were high, very high heritability (92.60%) along with very high GAM (41.83%) were observed for this trait.

4.1.2.6 Days to first male flower

In *kharif* season HUB- 6 took 29.70 days for first male flowering followed by HUB-1 (30.40) and HUB-7 (31.00). Whereas, Long White and HUB-16 took 41.20 days followed by HUB- 10 (40.90). The overall mean was 35.85 days. Low estimates of PCV (9.96%) and GCV (9.35%) with high heritability (88.05%) coupled with moderate GAM (18.07%) were noticed.

In *rabi* season HUB-1 took 36.45 days for first male flowering followed by HUB- 4 (37.95) and HUB-2 (38.20). Whereas, HUB-16 took 45.10 days. The overall mean was 40.98 days. Low estimates of PCV (5.90%) and GCV (3.43%) with moderate heritability (33.75%) coupled with low GAM (4.10%) were recorded.

In pooled average over both the seasons HUB-1 took 33.43 days for first male flowering followed by HUB- 4 (34.58) and HUB-7 (34.95). Whereas, HUB-16 took 43.15 days followed by HUB- 10 (42.38). The overall mean was 38.42 days. Low estimates of PCV (7.04%) and GCV (6.28%), high heritability (79.7%) coupled with moderate GAM (11.55%) were observed.

4.1.2.7 Days to first female flower

In *Kharif* season HUB- 6 (36.60) took minimum days for first female flowering followed by HUB-7 (37.35) and HUB-1 (37.50). Whereas, HUB-16 (47.10) took maximum days followed by HUB-22 (44.60). The overall mean was 41.38 days.

Low estimates of PCV (6.68%) and GCV (5.15%), moderate heritability (59.38%) coupled with low GAM (8.17%) were recorded for this trait.

In *rabi* season HUB-1 (42.75) took minimum days for first female flowering followed by HUB- 4 (43.60) and HUB-2 (43.80). Whereas, HUB-16 (52.70) took maximum days followed by IIHR-264 (51.60). The overall mean was 47.52 days. Low estimates of PCV (5.51%) and GCV (4.57%), high heritability (68.75%) along with low GAM (7.81%) were seen for this trait.

In pooled average over both the season HUB-1 (40.12) took minimum days for first female flowering followed by HUB- 6 (40.98) and HUB-2 (41.48). Whereas, HUB-1 (49.90) took maximum days. The overall mean was 44.45 days. Low estimates of PCV (5.42%) and GCV (4.63%), high heritability (73.1%) along with low GAM (8.16%) were recorded for this trait.

4.1.2.8 Node of first male flower appearance

In *kharif* season HUB-8 (2.10) showed early node of first female flower appearance followed by HUB-4 (2.30) and HUB-6 (2.40). Whereas in HUB- 17 (3.83) male flower appeared in later nodes. The average mean was 2.93. Moderate estimates of PCV (17.33%) and GCV (13.88%), high heritability (64.18%) coupled with high GAM (22.92%) were recorded for this trait.

In *rabi* season HUB-2 and HUB-8 (2.50) showed early node of first female flower appearance followed by HUB-4 (2.55). Whereas in IIHR-303 (4.15) male flower appeared in later nodes. The average mean was 3.02. Moderate PCV (15.56%) and GCV (11.10%), moderate heritability (52.96%) coupled with moderate GAM (16.64%) were noticed.

In pooled average over both the season HUB-8 (2.30) showed early node of first female flower appearance followed by HUB-4 (2.43) and HUB-6 (2.52). Whereas in HUB- 17 (3.91) male flower appeared in later nodes. The average mean was 2.97. Moderate PCV (15.19%) and GCV (12.86%), high heritability (71.6%) coupled with high GAM (22.42%) were recorded.

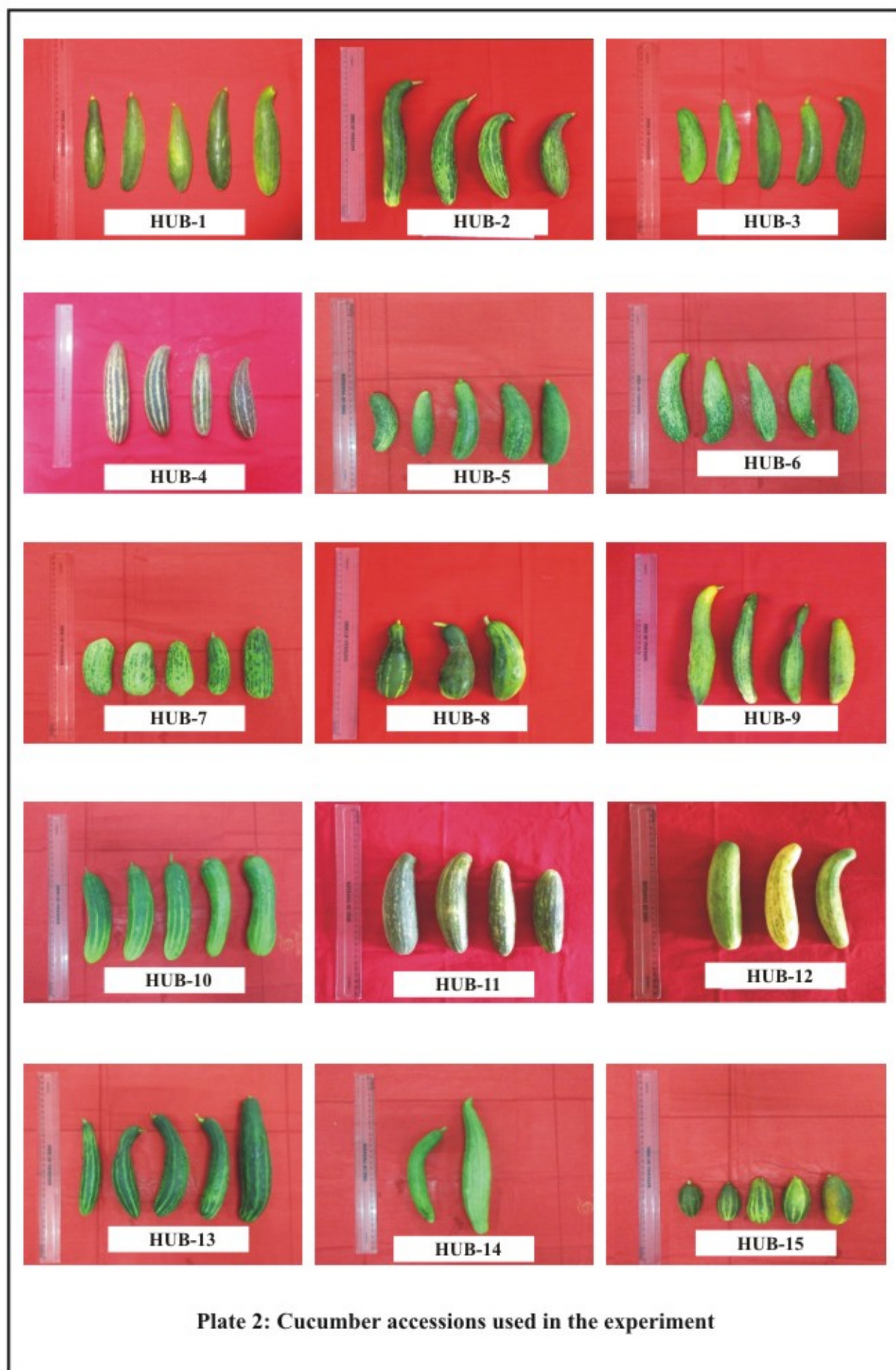


Plate 2: Cucumber accessions used in the experiment

Plate 2 contd.....



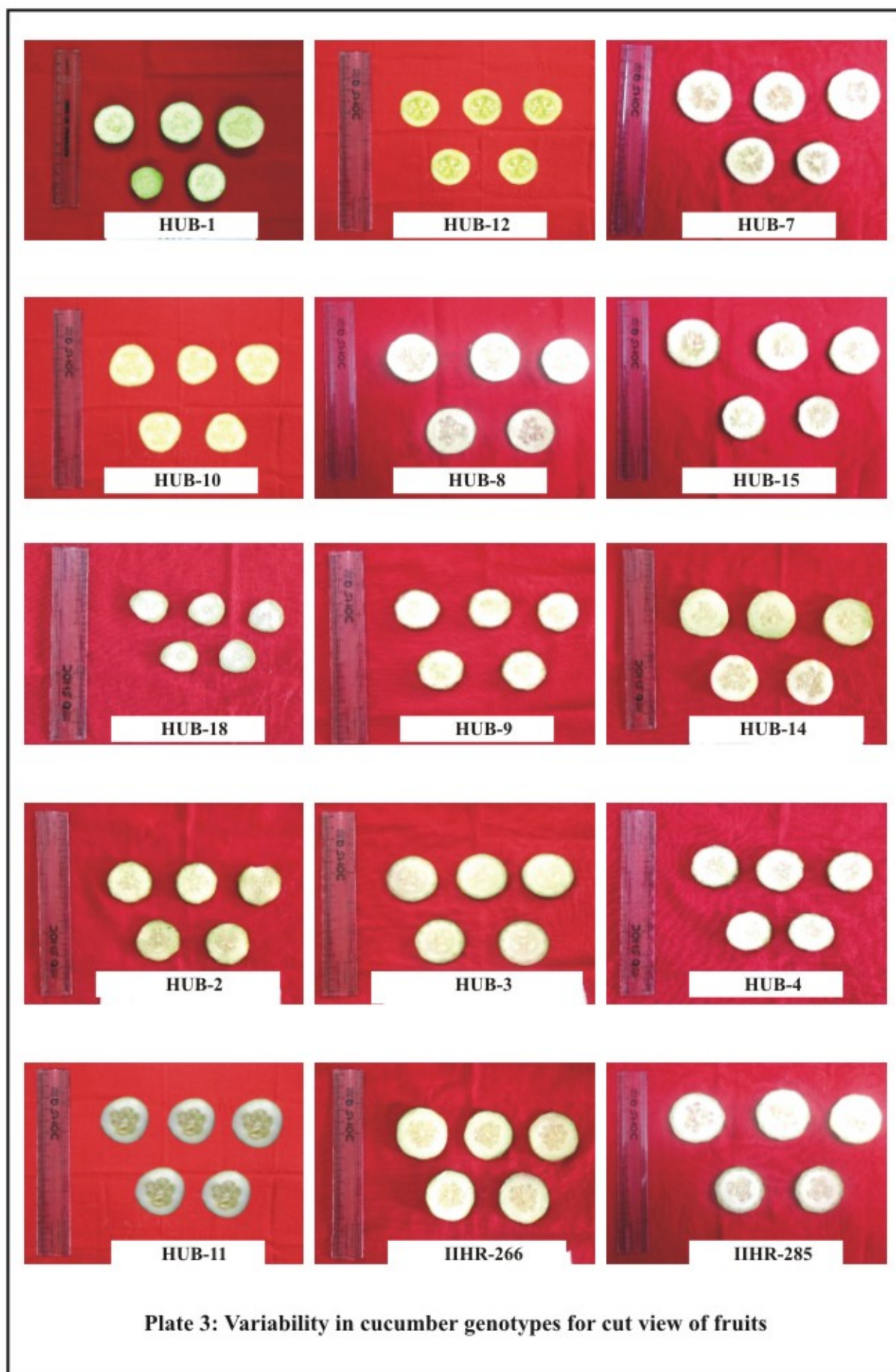
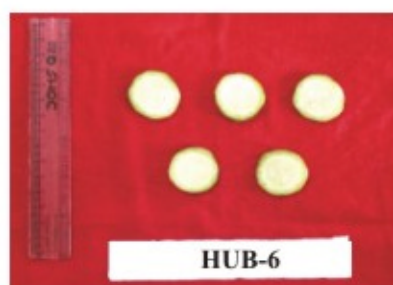
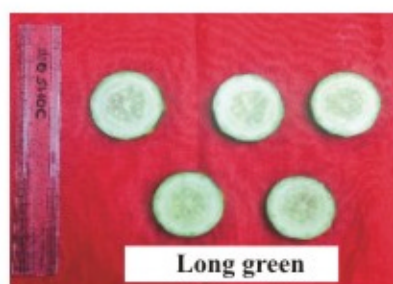


Plate 3 contd.....

4.1.2.9 Node of first female flower appearance

In *kharif* season Long White (3.90) showed early node of first female flower appearance followed by HUB-19 (4.00), HUB-13 and HUB- 10 (4.15). Whereas in HUB- 2 (5.60) male flower appeared in later nodes followed by HUB-3 (5.45). The overall mean was 4.70. Low estimates of PCV (10.85%) and GCV (8.22%), high heritability (60.47%) along with moderate GAM (12.84%) were recorded.

In *rabi* season HUB-13 (3.80) showed early node of first female flower appearance followed by Long White (3.85) and Long Green (3.90). Whereas in IIHR-303 (5.45) male flower appeared in later nodes. The overall mean was 4.53. Moderate PCV (11.01%) and low GCV (8.97%), high heritability (66.37%) along with moderate GAM (15.06%) were observed.

In pooled average over both the season Long White (3.87) showed early node of first female flower appearance followed by HUB-13 (3.98). Whereas in HUB- 3 and IIHR-303 (5.35) male flower appeared in later nodes. The overall mean was 4.62. Low estimates of PCV (9.99%) and GCV (8.57%), high heritability (73.6%) coupled with low GAM (15.15%) were recorded.

4.1.2.10 Number of male flowers per vine

In *kharif* season maximum number of male flowers per vine were recorded in HUB-3 (115.50) followed by HUB-1 (111.00) and HUB-2 (109.00). Whereas, minimum number of male flowers per vine was recorded in Poona Khira (62.50). Overall mean was 93.82. Moderate estimates of PCV (16.10%) and GCV (15.50%) were associated with high heritability (92.62%) and GAM (30.73%).

In *rabi* season maximum number of male flowers per vine were recorded in HUB-2 (103.50) followed by HUB-3 (97.00) and HUB-19 (93.00). Whereas, minimum number of male flowers per vine was seen in HUB-16 (47.00). The grand mean was 79.16. Moderate estimates of PCV (18.69%) and GCV (18.04%) with high heritability (93.22%) coupled with high GAM (35.89%) were recorded.

In pooled average over both the season maximum number of male flowers per vine were recorded in HUB-3 (106.55) followed by HUB-2 (106.25), HUB-1 (101.50)

and HUB-21 (98.13). Whereas, minimum number of male flowers per vine was recorded in Poona Khira (54.75). The overall mean was 86.49. Moderate estimates of PCV (16.97%) and GCV (16.66%), very high heritability (96.3%) coupled with high GAM (33.67%) were observed.

4.1.2.11 Number of female flowers per vine

In *kharif* season number of female flowers per vine ranged from 10.25 to 17.90 with the grand mean of 14.05. The maximum number of female flowers per vine were noted in IIHR-266 (17.90) followed by Poinsett (17.40). Whereas, minimum number of female flowers per vine were noted in HUB-11 (10.25). Moderate estimates of PCV (16.53%) and GCV (15.13%) were associated with high heritability (83.78%) and GAM (28.52%).

In *rabi* season maximum number of female flowers per vine were recorded in HUB-1 (16.00) followed by IIHR-303 (15.20) and HUB-9 (15.10). Whereas, minimum number of female flowers per vine were recorded in HUB-11 (7.65). The overall mean was 11.53. Moderate estimates of PCV (18.57%) and GCV (16.13%), very high heritability (75.45%) along with high GAM (28.86%) were recorded.

In pooled average over both the season maximum number of female flowers per vine were noticed in HUB-1 (16.25) followed by HUB-9 (15.90) and IIHR-303 (15.85). Whereas, minimum number of female flowers per vine were noticed HUB-1 (7.65). The overall mean recorded was 12.79. Moderate estimates of PCV (16.16%) and GCV (15.19%), high heritability (88.4%) coupled with high GAM (29.43%) were observed for this trait.

4.1.2.12 Sex ratio (male: female)

In *kharif* season sex ratio among the genotypes of cucumber ranged from 4.57 (Poona Khira) to 9.08 (HUB-20), with overall mean of 6.80. Moderate PCV (17.89%) and GCV (16.36%) along with very high heritability (83.66%) and high GAM (30.83%) were noticed for this trait.

In *rabi* season sex ratio among the genotypes of cucumber ranged from 4.03 (HUB-16) to 10.13 (HUB-20), with overall mean of 7.02. High PCV (22.45%) and

moderate GCV (19.83%) and along with high heritability (78.05%) and high GAM (36.10%) were recorded.

In pooled average over both the season sex ratio ranged from 4.43 (Poona Khira) to 9.60 (HUB-20), with overall mean of 6.91. Moderate estimates of PCV (18.98%) and GCV (17.82%), high heritability (88.1%) coupled with high GAM (34.46%) were noticed for this parameter.

4.1.2.13 Fruit setting percentage

In *kharif* season fruit setting percentage ranged from 29.60 (Poinsett) to 52.98 (HUB-17) with grand mean of 39.24 percent. Moderate estimates of PCV (19.13%) and GCV (16.62%), high heritability (74.45%) coupled with high GAM (29.74%) were recorded.

In *rabi* season fruit setting percentage ranged from 33.06 (HUB-14) to 65.03 (HUB-22) with grand mean of 50.25 percent. Estimates of PCV (16.07%) and GCV (12.44%) were moderate. The trait showed moderate heritability (59.97 %) coupled with moderate GAM (19.85%).

In pooled average over both the season fruit setting percentage ranged from 32.46 (HUB-14) to 58.08 (HUB-22) with grand mean of 44.75 percent. Estimates of PCV (14.84%) and GCV (13.28%) were moderate. The trait had high heritability (80.09%) coupled with high GAM (24.49%).

4.1.2.14 Number of fruits per vine

In *kharif* season number of fruits per vine ranged from 3.65 (HUB-14) to 7.80 (IIHR-303) with overall mean of 5.31. Moderate estimates of PCV (17.00%) and GCV (15.24%) with high heritability (80.39%) and high GAM (28.16%) were observed this parameter.

In *rabi* season number of fruits per vine ranged from 2.60 (HUB-14) to 9.15 (IIHR-303) with overall mean of 5.81. The high estimates of PCV (22.74%) and GCV (21.12%) with high heritability (86.31%) and high GAM (40.43%) were observed among the genotypes for this trait.

In pooled average over both the season number of fruits per vine ranged from 3.20 (HUB-14) to 8.47 (IIHR-303) with grand mean of 5.66. Moderate estimates of PCV (18.46%) and GCV (17.66%) with high heritability (91.58%) and high GAM (34.83%) were recorded.

4.1.2.15 Average fruit weight (g)

In *kharif* season average fruit weight was maximum in HUB-10 (236.80 g), followed by Long Green (219.40g) and HUB-16 (215.90 g), and minimum fruit weight was observed in HUB- 15 (52.85g). Overall mean was 154.23g. High estimates of PCV (25.88%) and GCV (25.23%), very high heritability (95.02 %) along with very high GAM (50.66%) were noticed for this trait.

In *rabi* season average fruit weight was maximum in HUB-16 (238.35 g) followed by HUB-10 (232.90g) and Long White (230.90 g). Whereas minimum fruit weight was observed in HUB- 15 (53.41 g). overall mean was 157.08 g. High estimates of PCV (27.71%) and GCV (26.96%), very high heritability (94.68 %) coupled with very high GAM (54.04%) were observed for this trait.

In pooled average over both the season average fruit weight was maximum in HUB-10 (234.85 g), followed by HUB-16 (227.13 g) and Long Green (222.40 g). Whereas minimum fruit weight was observed in HUB- 15 (53.13 g). Overall mean was 155.65g. High estimates of PCV (26.54%) and GCV (26.09%), very high heritability (96.62 %) coupled with very high GAM (52.83%) were exhibited by this trait.

4.1.2.16 Fruit length (cm)

In *kharif* season fruit length was maximum in IIHR-285 (18.75 cm) followed by HUB-13 (17.65 cm) and HUB-9 (17.20 cm). Whereas minimum fruit length was observed in HUB-15 (4.90 cm). Fruit length ranged from 4.90 to 18.75 cm with mean of 14.14 cm. High estimates of PCV (24.42%) and GCV (23.57%), along with very high heritability (93.20%) and GAM (46.88%) were noticed for this trait.

In *rabi* season maximum fruit length was recorded in HUB-9 (19.70 cm) followed by HUB-16 (17.00 cm) and HUB-13 (16.91 cm). Whereas minimum fruit

length was observed in HUB-15 (4.56 cm). Overall mean was 13.70 cm. High estimates of PCV (26.02%) and GCV (24.98%), along with very high heritability (92.19%) and GAM (49.41%) were recorded.

In pooled average over both the season maximum fruit length was recorded in HUB-9 (18.45 cm) followed by IIHR-285 (17.85 cm), and HUB-13 (17.28 cm). Whereas minimum fruit length was observed in HUB-15 (4.73cm). Overall mean was 13.85 cm. High estimates of PCV (24.65%) and GCV (24.14%), along with very high heritability (95.89%) and GAM (48.70%) were noted for this trait.

4.1.2.17 Circumference of fruit (cm)

In *kharif* season circumference of fruit ranged from 11.33 (IIHR-303) to 15.55 cm (HUB-10) with grand mean of 13.44 cm. Low estimates of PCV (9.39%) and GCV (8.00%), high heritability (72.56%) coupled with moderate GAM (14.04%) were observed for this trait.

In *rabi* season circumference of fruit ranged from 11.25 (HUB-5) to 15.75 cm (HUB-10) with grand mean of 13.57 cm. Low estimates of PCV (9.18%) and GCV (7.11%), high heritability (60.04%) along with moderate GAM (11.36%) were noticed.

In pooled average over both the season circumference of fruit ranged from 11.92 (HUB-15) to 15.65 cm (HUB-10) with grand mean of 13.51 cm. Low estimates of PCV (8.43%) and GCV (7.67%), high heritability (82.89%) coupled with moderate GAM (14.39%) were recorded.

4.1.2.18 Fruit yield per vine (kg)

In *kharif* season fruit yield per vine was maximum in Long White (1.22 kg) followed by Long Green (1.21 kg), HUB-10 (1.19 kg) and IIHR-266 (1.13 kg). Minimum yield was observed in HUB-15 (0.33 kg) with grand mean of 0.82 kg. High estimates of PCV (29.41%) and GCV (26.61%) with very high heritability (83.44%) and GAM (50.08%) were observed.

In *rabi* season fruit yield per vine was maximum in HUB-10 (1.45 kg) followed by HUB-1 (1.35 kg) and IIHR-303 (1.30 kg), and minimum in HUB-15

(0.33 kg). Overall mean was 0.91 kg. The high estimates of PCV (34.59%) and GCV (32.97%) with very high heritability (90.86%) and GAM (64.75%) were noticed for this trait.

In pooled average over both the season fruit yield per vine was maximum in HUB-10 (1.32 kg) followed by Long Green (1.23 kg), Long White (1.22 kg) and IHR-266 (1.19 kg). Whereas minimum yield was observed in HUB-15 (0.33 kg). The overall mean was 0.86 kg. High estimates of PCV (30.81%) and GCV (29.60%) with very high heritability (92.31%) and GAM (58.59%) were recorded.

4.1.2.19 Fruit yield per plot (kg)

In *kharif* season fruit yield per plot ranged from 3.28 (HUB-15) to 12.26 kg (Long White) with grand mean of 8.24 kg. The high estimates of PCV (29.08%) and GCV (26.60%) with very high heritability (83.63%) and GAM (50.11%) were noticed for this parameter.

In *rabi* season fruit yield per plot ranged from 3.28 (HUB-15) to 14.46 kg (HUB-10) with grand mean of 9.11 kg. The high estimates of PCV (34.59%) and GCV (32.98%) with very high heritability (90.90%) and GAM (64.78%) were observed.

In pooled average over both the season fruit yield per plot ranged from 3.28 (HUB-15) to 13.16 kg (HUB-10) with grand mean of 8.68 kg. The high estimates of PCV (30.83%) and GCV (29.63%) with very high heritability (92.36%) and GAM (58.66%) were exhibited by this trait.

4.1.2.20 Fruit yield per hectare (q)

In *kharif* season fruit yield per hectare ranged from 30.39 (HUB-15) to 113.52 q (Long White) with grand mean of 76.38 q. The high estimates of PCV (29.09%) and GCV (26.60%) with very high heritability (83.63%) and GAM (50.11%) were observed.

In *rabi* season fruit yield per hectare ranged from 30.37 (HUB-15) to 133.94 q (HUB-10) with grand mean of 84.40 q. High estimates of PCV (34.60%) and GCV (32.99%), very high heritability (90.90%) along with very high GAM (64.79%) were recorded.

In pooled average over both the season fruit yield per hectare ranged from 30.38 (HUB-15) to 121.85 q (HUB-10) with grand mean of 80.39 q. The high estimates of PCV (30.83%) and GCV (29.63%), very high heritability (92.34%) along with high GAM (58.65%) were noticed for parameter.

4.1.2.21 Flesh thickness (mm)

In *kharif* season flesh thickness was maximum in HUB-16 (19.93 mm) followed by HUB-10 (18.90 mm), HUB-3 (18.64 mm) and Long Green (17.75 mm), and minimum was observed in HUB-15 (7.65 mm). overall mean was 13.85 mm. Moderate estimates of PCV (18.56%) and GCV (17.65%) coupled with very high heritability (86.67%) and GAM (33.85%) were observed.

In *rabi* season flesh thickness was maximum in Long Green (20.30 mm) followed by HUB-3 (18.93 mm), Long White (18.81 mm) and HUB-16 (18.56 mm), and minimum was observed in HUB-17 (8.74 mm). Overall mean was 14.77 mm. Moderate estimates of PCV (18.45%) and GCV (17.15%) coupled with very high heritability (86.40%) and GAM (32.84%) were observed.

In pooled average over both the season flesh thickness was maximum in HUB-16 (19.25 mm) followed by, HUB-3 (18.78 mm) and Long Green (18.78mm). Minimum flesh thickness was observed in HUB-15 (8.42 mm). Overall mean was 14.41 mm. Moderate estimates of PCV (17.69%) and GCV (16.99%) coupled with very high heritability (92.30%) and GAM (33.64%) were exhibited.

4.1.2.22 Cavity thickness (mm)

In *kharif* season cavity thickness was maximum in HUB-7 (26.63 mm) followed by Long White (26.52 mm) and IIHR-266 (25.95 mm), minimum was observed for HUB-16 (18.27 mm). Overall mean was 23.76 mm. Low estimates of PCV (7.31%) and GCV (6.26%), high heritability (73.39%) along with moderate GAM (11.06%) were recorded.

In *rabi* season cavity thickness was maximum in Long White (27.24 mm) followed by IIHR-266 (26.69 mm) and HUB-7 (26.36 mm), and minimum was observed in HUB-16 (16.68mm). Overall mean was 23.47 mm. Low estimates of

PCV (9.59%) and GCV (7.53%), high heritability (61.57%) along with moderate GAM (12.17%) were observed.

In pooled average over both the season cavity thickness was maximum in Long White (26.88 mm) followed by HUB-7 (26.49 mm) and IIHR-266 (26.32 mm). Minimum was observed in HUB-16 (17.48 mm). Overall mean was 23.62 mm. Low estimates of PCV (7.91%) and GCV (7.09%), high heritability (80.40%) coupled with moderate GAM (13.10%) were noticed.

4.1.2.23 Vitamin C content (mg/100 g)

In *kharif* season vitamin C content ranged from 2.10 (IIHR-266) to 3.80 mg (HUB-18) with average mean of 2.89 mg. Estimates of PCV (15.49%) and GCV (13.41%) were moderate, high heritability (74.87%) along with high GAM (23.90%) were observed.

In *rabi* season vitamin C content ranged from 2.14 (HUB-17) to 4.49 mg (HUB-16) with average mean of 3.37 mg. Estimates of PCV (19.23%) and GCV (16.47%) were moderate, high heritability (73.37%) along with high GAM (29.06%) were noticed for this trait.

In pooled average over both the season vitamin C content ranged from 2.20 (HUB-17) to 4.00 mg (HUB-16) with average mean of 3.13 mg. Estimates of PCV (16.49%) and GCV (15.28%) were moderate, high heritability (85.90%) along with high GAM (29.18%) were recorded.

4.1.2.24 Total soluble solids (⁰ Brix)

In *kharif* season total soluble solids content ranged from 2.15 (HUB-20) to 3.15 ⁰brix (HUB-3) with overall grand mean of 2.56⁰ brix. Low estimates of PCV (8.81%) and GCV (7.73%), high heritability (77.11%) coupled with moderate GAM (13.99%) were noticed.

In *rabi* season total soluble solids content ranged from 2.42 (HUB-16) to 3.39 ⁰brix (HUB-5) with overall grand mean of 2.78 ⁰brix. Low estimates of PCV (10.83%) and GCV (8.82%), high heritability (72.31%) along with moderate GAM (15.46%) were observed.



Plate 4: Variability in cucumber genotypes used in the experiment

In pooled average over both the season total soluble solids content ranged from 2.32 (HUB-20) to 3.24 °brix (HUB-3) with grand mean of 2.66 °brix. Low estimates of PCV (9.31%) and GCV (8.28%), high heritability (79.00%) coupled with moderate GAM (15.61%) were observed.

4.2 Genetic divergence

The clustering pattern of thirty diverse genotypes of cucumber was made on the basis of Mahalanobis's D^2 analysis for various traits under study. All the genotypes were grouped into clusters by using Tocher's method.

4.2.1 Relative contribution of different characters towards divergence

In *kharif* season, the relative contribution of different characters for genetic divergence (D^2) is given in Table 8. Fruit yield per vine (19.08%) contributed maximum to the genetic diversity among the characters followed by fruit length (17.14%), fruit yield per plot (15.86%), cavity thickness (14.71%), leaf area (12.64%), flesh thickness (8.97%), circumference of fruit (6.21%), internodal length (1.38%), days to first male flowering (1.38%), average fruit weight (1.15%), node of first female flower appearance (0.46%), number of female flower per vine (0.46%), number of male flowers per vine (0.23%) and fruit setting per cent (0.23%). However, there was no contribution from vine length, number of leaves per vine, number of branches per vine, node of first female flower appearance, days to first female flowering, sex ratio and number of fruits per vine.

In *rabi* season, the relative contribution of different characters for genetic divergence (D^2) is given in Table 9. Circumference of fruit (46.21%) contributed maximum to the genetic diversity among the characters followed by leaf area (24.14%), flesh thickness (6.21%), fruit yield per vine (5.29%), fruit setting per cent (5.06%), fruit length (4.37%), average fruit weight (2.76%), fruit yield per plot (2.53%), cavity thickness (1.38%), number of fruits per vine (0.69%), number of male flowers per vine (0.46%), sex ratio (0.46%), number of leaves per vine (0.23%) and internodal length (0.23%). However, there was no contribution from vine length, number of branches per vine, node of first female flower appearance, node of first female flower appearance, days to first male flowering, days to first female flowering and number of female flowers per vine.

Table 8. Per cent contribution of different traits to total diversity in cucumber (Kharif season)

Sl. No	Source	Times ranked 1 st	Per cent contribution
1	Fruit yield per vine	83	19.08
2	Fruit length	75	17.14
3	Fruit yield per plot	69	15.86
4	cavity thickness	64	14.71
5	Leaf area	55	12.64
6	Flesh thickness	39	8.97
7	Circumference of fruit	27	6.21
8	Internodal length	6	1.38
9	Days to first male flowering	6	1.38
10	Average fruit weight	5	1.15
11	Node of first female flower appearance	2	0.46
12	Number of female flower per vine	2	0.46
13	Number of male flower per vine	1	0.23
14	Fruit setting per cent	1	0.23
15	Vine length	0	-
16	Number of leaves per vine	0	-
17	Number of branches per vine	0	-
18	Node of first male flower appearance	0	-
19	Days to first female flowering	0	-
20	Sex ratio	0	-
21	Number of fruits per vine	0	-
	Total	435	100

Table 9. Per cent contribution of different traits to total diversity in cucumber (Rabi season)

Sl. No.	Source	Times ranked 1 st	Per cent contribution
1	Circumference of fruit	201	46.21
2	Leaf area	105	24.14
3	Flesh thickness	27	6.21
4	Fruit yield per vine	23	5.29
5	Fruit setting per cent	22	5.06
6	Fruit length	19	4.37
7	Average fruit weight	12	2.76
8	Fruit yield per plot	11	2.53
9	cavity thickness	6	1.38
10	Number of fruits per vine	3	0.69
11	Number of male flower per vine	2	0.46
12	Sex ratio	2	0.46
13	Number of leaves per vine	1	0.23
14	Internodal length	1	0.23
15	Vine length	0	-
16	Number of branches per vine	0	-
17	Node of first male flower appearance	0	-
18	Node of first female flower appearance	0	-
19	Days to first male flowering	0	-
20	Days to first female flowering	0	-
21	Number of female flower per vine	0	-
	Total	435	100

In pooled average over both the seasons, the relative contribution of different characters for genetic divergence (D^2) is given in Table 10. Leaf area (29.43%) contributed maximum to the genetic diversity among the characters followed by fruit yield per vine (26.90%), fruit yield per plot (17.7%), cavity thickness (5.52%), fruit length (4.6%), circumference of fruit (4.6%), fruit setting per cent (2.53%), sex ratio (2.07%), number of female flower per vine (1.84%), number of fruits per vine (0.92%), average fruit weight (0.92%), number of leaves per vine (0.69%), internodal length (0.46%), number of male flowers per vine (0.46%), vine length (0.46%), number of branches per vine (0.23%), node of first female flower appearance (0.23%), days to first male flowering (0.23%) and flesh thickness (0.23%). However, there was no contribution from node of first female flower appearance and days to first female flowering.

4.2.2 Classification of cucumber genotypes

Following the method suggested by Tocher, 30 genotypes were grouped into clusters by treating estimated D^2 values as the square of the generalized distance. The distribution of entries into various clusters in *khariif*, *rabi* and pooled average over both the season is given in Table 11, 12 and 13.

In *khariif* season, all 30 genotypes were classified into VIII clusters. Cluster I was the largest having 12 genotypes followed by cluster III and V with 5 genotypes, cluster IV with 4 genotypes and cluster II, VI, VII and VIII having 1 genotype each. Average intra and inter cluster distances are presented in Table 14. The diagonal figures in the table represent the intra cluster distances. The intra cluster distance was found maximum in cluster V (387.92) followed by cluster IV (296.64), cluster III (221.41) and cluster I (219.21). The distance was zero in remaining 4 clusters, since they have single genotype. Highest inter cluster distance was recorded between cluster II and III (2532.09) closely followed by cluster III and VI (2423.17), cluster III and VII (2405.04), cluster I and III (1851.37) and cluster IV and V (1206.64). The least inter cluster distance was observed between cluster VI and VII (244.6).

In *rabi* season, all 30 genotypes were grouped into 7 clusters. Cluster I was the largest having 15 genotypes followed by cluster II with 5 genotypes, cluster III with 4 genotypes, cluster V with 3 genotypes, cluster IV, VI and VII having 1 genotype each.

Table 10. Per cent contribution of different traits to total diversity in cucumber (Pooled average over both the seasons)

Sl. No	Source	Times ranked 1 st	Per cent contribution
1	Leaf area	128	29.43
2	Fruit yield per vine	117	26.9
3	Fruit yield per plot	77	17.7
4	cavity thickness	24	5.52
5	Fruit length	20	4.6
6	Circumference of fruit	20	4.6
7	Fruit setting per cent	11	2.53
8	Sex ratio	9	2.07
9	Number of female flower per vine	8	1.84
10	Number of fruits per vine	4	0.92
11	Average fruit weight	4	0.92
12	Number of leaves per vine	3	0.69
13	Vine length	2	0.46
14	Internodal length	2	0.46
15	Number of male flower per vine	2	0.46
16	Number of branches per vine	1	0.23
17	Node of first female flower appearance	1	0.23
18	Days to first male flowering	1	0.23
19	Flesh thickness	1	0.23
20	Node of first male flower appearance	0	-
21	Days to first female flowering	0	-
	Total	435	100

Table 11. Cluster composition of 30 genotypes of cucumber based on 21 traits in D^2 analysis (*kharif* season)

Sl. No.	Cluster number	No. of genotypes	Genotype name
1	Cluster I	12	HUB-2, HUB-4, HUB-6, HUB-19, HUB-3, HUB-9, HUB-18, HUB-5, HUB-8, HUB-13, HUB-20, HUB-23
2	Cluster II	1	HUB-7
3	Cluster III	5	Long Green, Long White, HUB-10, HUB-16, HUB- 22
4	Cluster IV	4	HUB-11, HUB-14, HUB-21, Poinsett
5	Cluster V	5	HUB-1, HUB-26, HUB-24, HUB-25, HUB-12
6	Cluster VI	1	HUB-15
7	Cluster VII	1	HUB-17
8	Cluster VIII	1	Poona Khira

Table 12. Cluster composition of 30 genotypes of cucumber based on 21 traits in D^2 analysis (*Rabi* season)

Sl. No.	Cluster number	No. of genotypes	Genotype name
1	Cluster I	15	HUB-11, HUB-14, HUB-8, HUB-5, HUB-7, HUB-21, HUB-3, Poinsett, HUB-19, HUB-6, HUB-13, HUB-4, HUB-24, HUB-18, HUB-2
2	Cluster II	5	Long Green, Long White, HUB-10, HUB- 22, HUB-16
3	Cluster III	4	HUB-12, HUB-25, HUB-36, HUB-1
4	Cluster IV	1	HUB-20
5	Cluster V	3	HUB-15, HUB-17, HUB-23
6	Cluster VI	1	HUB-9
7	Cluster VII	1	Poona Khira

Table 13. Cluster composition of 30 genotypes of cucumber based on 21 traits in D^2 analysis (Pooled average over both the seasons)

Sl. No.	Cluster number	No. of genotypes	Genotype name
1	Cluster I	12	HUB-2, HUB-6, HUB-5, HUB-19, HUB-4, HUB-3, HUB-13, HUB-24, HUB-21, HUB-18, HUB-8, HUB-14
2	Cluster II	4	HUB-12, HUB-25, Poinsett, Poona Khira
3	Cluster III	3	HUB-10, Long Green, Long White,
4	Cluster IV	1	HUB-11
5	Cluster V	1	HUB-9
6	Cluster VI	4	HUB-15, HUB-17, HUB-20, HUB-7
7	Cluster VII	1	HUB-16
8	Cluster VIII	1	HUB-23
9	Cluster IX	2	HUB-1, HUB-26
10	Cluster X	1	HUB-22

Table 14. Average inter and intra cluster distances for 21 traits in D² analysis (*kharif* season)

Clusters	I	II	III	IV	V	VI	VII	VIII
I	219.21	339.55	1851.37	381.19	716.71	415.56	519.81	602.94
II		0.000	2532.09	608.27	1088.49	321.51	328.84	1009.16
III			221.41	2149.6	1096.28	2423.17	2405.04	653.72
IV				296.64	1206.64	614.49	1060.9	712.12
V					387.92	1165.63	867.19	660.24
VI						0.000	244.6	870.81
VII							0.000	1075.55
VIII								0.000

Bold diagonal value indicates intra cluster distance

Average intra and inter cluster distances are presented in Table 15. The diagonal figures in the table represent the intra cluster distances. The intra cluster distance was found maximum in cluster V (375.58) followed by cluster III (334.77), cluster II (311.58) and cluster 1 (273.14). The distance was zero in remaining 3 clusters. Maximum divergence among clusters were recorded between cluster II and VI (4692.32) closely followed by cluster I and II (3432.5), cluster II and V (3126.31), cluster II and IV (3062.74), cluster VI and VII (2577.66) and cluster II and III (2166.4). The least inter cluster distance was observed between cluster IV and V (224.18).

In pooled average over both the season, all 30 genotypes were grouped into 10 clusters. Cluster I was the largest having 12 genotypes followed by cluster II and cluster VI with 4 genotypes, cluster III with 3 genotypes, cluster IX with 2 genotypes, cluster IV, V, VII, VIII and X having 1 genotype each. Average intra and inter cluster distances are presented in Table 16. The diagonal figures in the table represent the intra cluster distances. The intra cluster distance was found maximum in cluster II (320.94) closely followed by cluster III (307.84), cluster IX (274.51), cluster I (270.44) and cluster VI (263.81). The distance was zero in remaining 5 clusters.

Highest inter cluster distance was recorded between cluster III and VI (6818.97) closely followed by cluster IV and VII (6713.33), cluster 1 and VII (5618.69), cluster V and VII (5490.35), cluster VI and X (4511.73), cluster V and X (4176.96) and cluster III and IV (4136.1). The least inter-cluster distance was observed among cluster I and V (501.01).

4.2.3 Cluster means

The mean values of 21 different characters for seven clusters are summarized in Table 17, 18 and 19.

4.2.3.1 Vine length

In *kharif* season highest cluster mean was observed in cluster III (194.48) followed by cluster V (167.24). In contrast cluster VI (123.5) showed lowest cluster mean. In *rabi* season highest cluster mean was observed in cluster II (177.96) followed by cluster III (159.71). Cluster IV (102.5) showed lowest cluster mean.

Table 15. Average inter and intra cluster distances for 21 traits in D² analysis (Rabi season)

Clusters	I	II	III	IV	V	VI	VII
I	273.14	3432.5	781.45	652.33	690.11	601.58	1457.36
II		311.58	2166.4	3062.74	3126.31	4692.32	827.31
III			334.77	1480.67	1402.28	862.52	1152.44
IV				0.000	224.18	1952.39	1191.3
V					375.58	1857.11	1179.23
VI						0.000	2577.66
VII							0.000

Bold diagonal value indicates intra cluster distance

Table 16. Average inter and intra cluster distances for 21 traits in D² analysis (Pooled average over both the seasons)

Clusters	I	II	III	IV	V	VI	VII	VIII	IX	X
I	270.44	881.21	3507.84	630.52	501.01	2049.34	5618.69	633.7	928.73	3095.3
II		320.94	1563.31	1516.41	933.77	3668.2	2707.81	1033.07	857.16	1605.78
III			307.84	4136.1	3836.97	6818.97	730.31	3052	2266.73	752.1
IV				0.000	1421.41	1297.32	6713.33	489.33	1630.38	3187.15
V					0.000	3750.9	5490.35	1598.8	1338.91	4176.96
VI						263.81	10276.72	1080.37	2800.89	4511.73
VII							0.000	5295.08	3804.43	1798.95
VIII								0.000	1090.33	1943.03
IX									274.51	1846.08
X										0.000

Bold diagonal value indicates intra cluster distance

Table 17. Cluster means for 21 traits from D² analysis (*kharif* season)

Sl. No.	Characters	Rank	I	II	III	IV	V	VI	VII	VIII
1	Vine length (cm)		138.57	125.2	197.4	124.21	167.24	123.5	136.8	147.4
		R	4	6	1	7	2	8	5	3
2	Number of leaves at 90 DAS		84.84	72.95	59.08	75.09	106.13	82.35	82.6	64.05
		R	2	6	8	5	1	4	3	7
3	Number of branches per vine at 75 DAS		4.48	3.25	2.64	3.55	4.25	4.2	3.65	3.25
		R	1	6	7	5	2	3	4	6
4	Internodal length (cm)		5.48	4.23	8.99	6.46	7.08	6.23	5.25	12.2
		R	6	8	2	4	3	5	7	1
5	Leaf area (cm ²)		147.82	97	310.98	141.95	254.73	136.5	106.25	203.65
		R	4	8	1	5	2	5	7	3
6	Node of first male flower appearance		2.76	2.85	3.17	2.72	3.18	2.7	3.83	2.8
		R	3	5	6	2	7	1	8	4
7	Node of first female flower appearance		4.67	4.65	4.4	4.76	5.13	4.65	4.85	4.4
		R	3	2	1	4	6	2	5	1
8	Days to first male flowering		33.88	31	40.28	36.47	36.2	39.4	37.9	32.6
		R	3	1	8	5	4	7	6	2
9	Days to first female flowering		40.12	37.35	44.47	41.23	41.58	44.1	43.1	40.55
		R	2	1	8	4	5	7	6	3
10	Number of male flowers per vine		102.09	99.85	68.82	96.06	100.36	100.85	96.35	62.5
		R	1	4	7	6	3	2	5	8

Contd.....

Sl. No.	Characters	Rank	I	II	III	IV	V	VI	VII	VIII
11	Number of female flowers per vine		14.93	13.7	11.91	12.81	16.02	12	12.1	13.7
		R	2	3	7	4	1	6	5	3
12	Sex ratio (male: female)		6.94	7.3	5.86	7.73	6.5	8.43	7.97	4.57
		R	5	4	7	3	6	1	2	8
13	Fruit setting per cent		35.84	38.35	44.51	35.73	40.81	51.71	52.98	34.73
		R	6	5	3	7	4	2	1	8
14	Number of fruits per vine		5.38	5.25	5.28	4.86	6.48	6.2	6.4	4.75
		R	4	6	5	7	1	3	2	8
15	Average fruit weight (g)		147.83	124.35	209.3	153.13	158.64	52.85	56.3	167.2
		R	5	6	1	4	3	8	7	2
16	Fruit length (cm)		13.83	9.7	15.58	15.24	15.87	4.9	5.62	16.05
		R	5	6	3	4	2	8	7	1
17	Circumference of the fruit (cm)		13	13.7	14.69	13.86	13.1	12.2	11.95	15.2
		R	6	4	2	3	5	7	8	1
18	Flesh thickness (mm)		14.25	12.99	17.12	13.53	13.41	7.65	8.49	14.87
		R	3	6	1	4	5	8	7	2
19	Cavity thickness (mm)		23.36	26.63	22.93	23.7	24.58	24.7	25.52	23.53
		R	7	1	8	5	4	3	2	6
20	Fruit yield per vine (kg)		0.78	0.66	1.09	0.7	1.00	0.33	0.36	0.8
		R	4	6	1	5	2	8	7	3
21	Fruit yield per plot (kg)		7.78	6.53	10.93	6.96	10.05	3.28	3.6	7.96
		R	4	6	1	5	2	8	7	3
	Total		77	100	88	98	70	106	111	83
		R	2	6	4	5	1	7	8	3

Table 18. Cluster means for 21 traits from D² analysis (Rabi season)

Sl. No.	Characters	Rank	I	II	III	IV	V	VI	VII
1	Vine length (cm)		111.84	177.96	159.71	102.5	108.47	132.75	110
		R	4	1	2	7	6	3	5
2	Number of leaves @ 90 DAS		69.67	49.99	97.68	45.9	58.08	90	48.45
		R	3	5	1	7	4	2	6
3	Number of branches per vine @ 75 DAS		3.63	2.45	4.3	3.9	3.82	4.2	3.05
		R	5	7	1	3	4	2	6
4	Internodal length (cm)		5.76	8.77	7.67	5.48	6.62	6.55	12.3
		R	6	2	3	7	4	5	1
5	Leaf area (cm ²)		134.26	291.99	261.81	107.5	118.69	139.8	184.6
		R	5	1	2	7	6	4	3
6	Node of first male flower appearance		2.8	3.2	3.35	3.45	3.32	2.85	3.13
		R	1	4	6	7	5	2	3
7	Node of first female flower appearance		4.54	4.25	5.05	4.15	4.48	4.8	4.15
		R	4	2	6	1	3	5	1
8	Days to first male flowering		40.28	43.01	39.59	41.25	43.3	40.05	40.65
		R	3	6	1	5	7	2	4
9	Days to first female flowering		46.26	49.96	46.6	50.1	50.02	47.2	48.2
		R	1	5	2	7	6	3	4
10	Number of male flowers per vine		86.8	56.2	81.75	88.5	80.33	88.5	47
		R	2	5	3	1	4	1	7

Contd.....

Sl. No.	Characters	Rank	I	II	III	IV	V	VI	VII
11	Number of female flowers per vine		11.52	10.4	13.24	8.75	11.12	15.1	11
		R	3	6	2	7	4	1	5
12	Sex ratio		7.68	5.57	6.38	10.13	7.28	5.87	4.29
		R	2	6	4	1	3	5	7
13	Fruit setting per cent		47.55	53.9	53.62	55.36	54.11	44.96	47.84
		R	6	3	4	1	2	7	5
14	Number of fruits per vine		5.57	5.52	7.14	4.85	5.98	6.8	5.2
		R	4	5	1	7	3	2	6
15	Average fruit weight (g)		149.71	216.62	161.69	110.3	89.14	187.39	172
		R	5	1	4	6	7	2	3
16	Fruit length (cm)		13.93	15.66	14.35	8	7.26	19.7	16.85
		R	5	3	4	6	7	1	2
17	Circumference of the fruit (cm)		13.25	14.79	13.48	13.3	12.62	13.9	15.7
		R	6	2	4	5	7	3	1
18	Flesh thickness (mm)		14.48	18.58	14.37	13.12	10.11	15.11	16.74
		R	4	1	5	6	7	3	2
19	Cavity thickness (mm)		23.42	22.83	23.32	24.91	24.66	23.66	23.07
		R	4	7	5	1	2	3	6
20	Fruit yield per vine (kg)		0.84	1.2	1.14	0.53	0.52	1.27	0.89
		R	5	2	3	6	7	1	4
21	Fruit yield per plot (kg)		8.37	11.97	11.35	5.34	5.23	12.66	8.94
		R	5	2	3	6	7	1	4
	Total		83	76	66	104	105	58	85
		R	4	3	2	6	7	1	5

Table 19. Cluster means for 21 traits from D² analysis (Pooled average over both the seasons)

Sl. No	Characters	Rank	I	II	III	IV	V	VI	VII	VIII	IX	X
1	Vine length (cm)		125.29	139.06	187.28	101.88	137.53	118.39	204.55	126.8	179.88	169.5
		R	8	5	2	10	6	9	1	7	3	4
2	Number of leaves at 90 DAS		79.68	82.81	51.9	48.68	94	67.31	59.5	55.48	108.94	57.48
		R	4	3	9	10	2	5	6	8	1	7
3	Number of branches per vine at 75 DAS		4.16	3.86	2.8	2.05	4.3	3.63	1.88	3.85	4.41	2.45
		R	3	4	7	9	2	6	10	5	1	8
4	Internodal length (cm)		5.41	9.05	8.28	6.21	6.51	5.5	11.28	7.5	7.41	8.32
		R	10	2	4	8	7	9	1	5	6	3
5	Leaf area(cm ²)		144.58	239.28	291.71	77.8	144.28	106.54	315.48	146.77	258.36	316.81
		R	7	5	3	10	8	9	2	6	4	1
6	Node of first male flower appearance		2.71	3.11	3.12	2.79	2.78	3.27	3.18	3.25	3.31	3.38
		R	1	4	5	3	2	8	6	7	9	10
7	Node of first female flower appearance		4.67	4.73	3.99	4.63	4.78	4.47	4.43	4.35	5.23	5.23
		R	6	7	1	5	8	4	3	2	9	9
8	Days to first male flowering		36.99	38.89	41.86	39.44	38.13	38.89	43.15	40.98	35.44	39.5
		R	2	4	8	5	3	4	9	7	1	6
9	Days to first female flowering		43.12	44.61	46.18	44.63	44.3	45.33	49.9	46.88	42.3	47.65
		R	2	4	7	5	3	6	10	8	1	9
10	Number of male flowers per vine		94.93	81.98	60.83	79.4	96.75	90.54	56	89.75	93.63	74.05
		R	2	6	9	7	1	4	10	5	3	8

Contd.....

Sl. No	Characters	Rank	I	II	III	IV	V	VI	VII	VIII	IX	X
11	Number of female flowers per vine		13.41	13.19	11.38	8.95	15.9	11.35	12.15	11.88	16.05	9.5
		R	3	4	7	10	2	8	5	6	1	9
12	Sex ratio		7.23	6.38	5.36	8.96	6.08	8.08	4.6	7.62	5.84	7.88
		R	5	6	9	1	7	2	10	4	8	3
13	Fruit setting per cent		41.53	42.47	49.28	35.99	38.92	52.12	40.1	44.8	50.04	58.09
		R	7	6	4	10	9	2	8	5	3	1
14	Number of fruits per vine		5.54	5.59	5.58	3.25	6.15	5.85	4.85	5.15	8.1	5.43
		R	6	4	5	10	2	3	9	8	1	7
15	Average fruit weight (g)		150.82	171.45	226.83	142.63	181.62	85.52	227.13	151.23	145.89	157.18
		R	7	4	2	9	3	10	1	6	8	5
16	Fruit length (cm)		14.57	16.59	16.22	12.93	18.45	6.91	16.58	11.28	13.08	12.86
		R	5	2	4	7	1	10	3	9	6	8
17	Circumference of the fruit (cm)		13.2	14.59	15.08	12.08	13.55	12.77	14.88	13.43	12.4	13.58
		R	7	3	1	10	5	8	2	6	9	4
18	Flesh thickness (mm)		14.32	14.66	17.96	14.43	15.35	10.85	19.25	12.37	13.55	16.13
		R	7	5	2	6	4	10	1	9	8	3
19	Cavity thickness (mm)		23.27	24.2	24.64	23.73	24.04	25.2	17.48	24.29	22.76	23.02
		R	7	4	2	6	5	1	10	3	9	8
20	Fruit yield per vine (kg)		0.83	0.94	1.26	0.46	1.12	0.49	1.1	0.79	1.17	0.86
		R	7	5	1	10	3	9	4	8	2	6
21	Fruit yield per plot (kg)		8.26	9.37	12.56	4.61	11.18	4.89	11.01	7.83	11.71	8.56
		R	7	5	1	10	3	9	4	8	2	6
	Total		113	88	93	156	86	136	115	137	95	125
		R	5	2	3	10	1	8	6	9	4	7

In pooled average over both the season highest cluster mean was observed in cluster VII (204.55) followed by cluster III (187.28). Cluster IV (101.88) showed lowest cluster mean for vine length.

4.2.3.2 Number of leaves per vine

In *kharif* season cluster V (106.13) showed highest cluster mean followed by cluster I (84.84). Least cluster mean was observed in cluster III (59.08). In *rabi* season cluster III (97.68) recorded highest cluster mean followed by cluster VI (90.00). Whereas, lowest cluster mean was seen in cluster IV (45.9). In pooled average over both the season cluster IX (108.94) showed highest cluster mean followed by cluster V (94.00). Least cluster mean was observed in cluster IV (48.68).

4.2.3.3 Number of branches per vine

In *kharif* season cluster I (4.48) recorded highest cluster mean followed by cluster V (4.25). Whereas, lowest cluster mean was seen in cluster III (2.64). In *rabi* season cluster III (4.3) showed highest cluster mean followed by cluster VI (4.20) and least cluster mean was observed in cluster II (2.45). In pooled average over both the season cluster IX (4.41) showed highest cluster mean followed by cluster V (4.30). Least cluster mean was observed in cluster VII (1.88).

4.2.3.4 Internodal length

In *kharif* season lowest cluster mean was recorded in cluster II (4.23) followed by cluster VII (5.25). In contrast, highest cluster mean was observed in cluster VIII (12.2). In *rabi* season highest cluster mean was recorded in cluster VII (12.3) followed by cluster II (8.77). Whereas, lowest cluster mean was observed in cluster IV (5.48). In pooled average over both the season highest cluster mean was recorded in cluster VII (11.28) followed by cluster II (9.05). Whereas, lowest cluster mean was observed in cluster I (5.41).

4.2.3.5 Leaf area

In *kharif* season highest cluster mean was recorded in cluster III (310.98). Whereas, lowest cluster mean was observed in cluster II (97). In *rabi* season highest cluster mean was recorded in cluster II (291.99) followed by cluster III (261.81).

While, lowest cluster mean was observed in cluster IV (107.5). In pooled average over both the season highest cluster mean was recorded in cluster X (316.81) followed by cluster VII (315.48). Whereas, lowest cluster mean was observed in cluster IV (77.8).

4.2.3.6 Node of first male flower appearance

In *kharif* season highest cluster mean was observed in cluster VII (3.83) followed by cluster V (3.18). Whereas, lowest cluster mean was recorded in cluster VI (2.7). In *rabi* season highest cluster mean was observed in cluster IV (3.45) followed by cluster III (3.35). Lowest cluster mean was recorded in cluster I (2.8). In pooled average over both the season highest cluster mean was observed in cluster X (3.38) followed by cluster IX (3.31) and lowest cluster mean was recorded in cluster I (2.71).

4.2.3.7 Node of first female flower appearance

In *kharif* season cluster V (5.13) recorded highest cluster mean followed by cluster VII (4.85). In contrast, lowest cluster mean was observed in cluster III and VIII (4.4). In *rabi* season cluster III (5.05) recorded highest cluster mean followed by cluster VI (4.8). Whereas, lowest cluster mean was observed in cluster VII (4.15). In pooled average over both the season cluster IX and X (5.23) recorded highest cluster mean followed by cluster V (4.78). Whereas, lowest cluster mean was observed in cluster III (3.99).

4.2.3.8 Days to first male flowering

In *kharif* season in days to first male flowering, cluster III (40.28) showed highest cluster mean. While, cluster II (31.00) recorded lowest cluster mean. In *rabi* season cluster V (43.3) showed highest cluster mean followed by cluster II (43.01). While, cluster III (39.59) recorded lowest cluster mean. In pooled average over both the season cluster VII (43.15) showed highest cluster mean followed by III (41.86) and cluster IX (35.44) recorded lowest cluster mean.

4.2.3.9 Days to first female flowering

In *kharif* season cluster III (44.47) recorded highest cluster mean followed by cluster VI (44.1). Whereas, lowest cluster mean was observed in cluster II (37.35). In *rabi* season cluster IV (50.1) recorded highest cluster mean closely followed by

cluster V (50.02). While, lowest cluster mean was observed in cluster I (46.26). In pooled average over both the season cluster VII (49.9) recorded highest cluster mean closely followed by cluster X (47.65). Whereas, lowest cluster mean was observed in cluster IX (42.3).

4.2.3.10 Number of male flowers per vine

In *kharif* season highest cluster mean was observed in cluster I (102.09), followed by cluster VI (100.85). Whereas, cluster VIII (62.5) showed lowest cluster mean. In *rabi* season highest cluster mean was observed in cluster IV and VI (88.5). Cluster VII (47) showed lowest cluster mean. In pooled average over both the season highest cluster mean was observed in cluster V (96.75) followed by cluster I (94.93). Cluster VII (56) showed lowest cluster mean for number of male flowers.

4.2.3.11 Number of female flowers per vine

In *kharif* season cluster V (16.02) recorded highest cluster mean followed by cluster I (14.93). In contrast, lowest cluster mean was observed in cluster III (11.91). In *rabi* season cluster VI (15.1) recorded highest cluster mean followed by cluster III (13.24). Whereas, lowest cluster mean was observed in cluster IV (8.75). In pooled average over both the season cluster IX (16.05) recorded highest cluster mean followed by cluster V (15.9). Whereas, lowest cluster mean was observed in cluster IV (8.95).

4.2.3.12 Sex ratio

In *kharif* season lowest cluster mean was recorded in cluster VIII (4.57). Whereas, highest cluster mean was observed in cluster VI (8.43). In *rabi* season highest cluster mean was observed in cluster IV (10.13) followed by cluster I (7.68). While, lowest cluster mean was recorded in cluster VII (4.29). In pooled average over both the season highest cluster mean was observed in cluster IV (8.96) followed by cluster VI (8.08). Whereas, lowest cluster mean was recorded in cluster VII (4.6).

4.2.3.13 Fruit setting percent

In *kharif* season cluster VII (52.98) recorded highest cluster mean followed by cluster VI (51.71). Whereas, lowest cluster mean was observed in cluster VIII (34.73). In *rabi* season cluster IV (55.36) recorded highest cluster mean followed by cluster V

(54.11). Whereas, lowest cluster mean was observed in cluster VI (44.96). In pooled average over both the season cluster X (58.09) recorded highest cluster mean followed by cluster VI (52.12) and lowest cluster mean was observed in cluster IV (35.99).

4.2.3.14 Number of fruits per vine

In *kharif* season cluster V (6.48) recorded highest cluster mean followed by cluster VII (6.4) and lowest cluster mean was observed in cluster VIII (4.75). In *rabi* season cluster III (7.14) recorded highest cluster mean followed by cluster VI (6.8). While, lowest cluster mean was observed in cluster IV (4.85). In pooled average over both the season cluster IX (8.1) recorded highest cluster mean followed by cluster V (6.15). Whereas, lowest cluster mean was observed in cluster IV (3.25).

4.2.3.15 Average fruit weight

In *kharif* season highest cluster mean was recorded in cluster III (209.30) followed by cluster VIII (167.2). In contrast, lowest cluster mean was observed in cluster VI (52.85). In *rabi* season highest cluster mean was recorded in cluster II (216.62) followed by cluster VI (187.39). Whereas, lowest cluster mean was observed in cluster V (89.14). In pooled average over both the season highest cluster mean was recorded in cluster VII (227.13) followed by cluster III (226.83) and lowest cluster mean was observed in cluster VI (85.52).

4.2.3.16 Fruit length

In *kharif* season in fruit length, cluster V (15.87) showed highest cluster mean followed by cluster III (15.58). While, cluster VI (4.9) recorded lowest cluster mean. In *rabi* season cluster VI (19.7) showed highest cluster mean followed by cluster VII (16.85). While, cluster V (7.26) recorded lowest cluster mean. In pooled average over both the season cluster V (18.45) showed highest cluster mean followed by cluster II (16.59) and cluster VI (6.91) recorded lowest cluster mean.

4.2.3.17 Circumference of fruit

In *kharif* season highest cluster mean was observed in cluster VIII (15.20) followed by cluster IV (13.86). Cluster VII (11.95) showed lowest cluster mean. In

rabi season highest cluster mean was observed in cluster VII (15.7) followed by cluster II (14.79). Cluster V (12.62) showed lowest cluster mean. In pooled average over both the season highest cluster mean was observed in cluster III (15.08) followed by cluster VII (14.88). Whereas, cluster IV (12.08) showed lowest cluster mean.

4.2.3.18 Flesh thickness

In *kharif* season cluster III (17.12) recorded highest cluster mean followed by cluster VIII (14.87). Whereas, lowest cluster mean was observed in cluster VI (7.65). In *rabi* season cluster II (18.58) recorded highest cluster mean followed by cluster VII (16.74). In contrast, lowest cluster mean was observed in cluster V (10.11). In pooled average over both the season cluster VII (19.25) recorded highest cluster mean followed by cluster III (17.96) and lowest cluster mean was observed in cluster VI (10.85).

4.2.3.19 Cavity thickness

In *kharif* season cluster II (26.63) showed highest cluster mean followed by cluster VII (25.52). While, cluster III (22.93) recorded lowest cluster mean. In *rabi* season cluster IV (24.91) showed highest cluster mean followed by cluster V (24.66). While, cluster II (22.83) recorded lowest cluster mean. In pooled average over both the season cluster VI (25.2) showed highest cluster mean followed by cluster III (24.64). Cluster IV (17.48) recorded lowest cluster mean.

4.2.3.20 Fruit yield per vine

In *kharif* season highest cluster mean was observed in cluster III (1.09) followed by cluster V (1.00). In contrast cluster VI (0.33) showed lowest cluster mean for fruit yield per vine. In *rabi* season highest cluster mean was observed in cluster VI (1.27) followed by cluster II (1.20). Cluster V (0.52) showed lowest cluster mean. In pooled average over both the season highest cluster mean was observed in cluster III (1.26) followed by cluster IX (1.17). Cluster IV (0.46) showed lowest cluster mean.

4.2.3.21 Fruit yield per plot

In *kharif* season highest cluster mean was observed in cluster III (10.93) followed by cluster V (10.05). Cluster VI (3.28) showed lowest cluster mean for fruit

yield per plot. In *rabi* season highest cluster mean was observed in cluster VI (12.66) followed by cluster II (11.97), cluster V (5.23) showed lowest cluster mean. In pooled average over both the season highest cluster mean was observed in cluster III (12.56) followed by cluster IX (11.71). While, cluster IV (4.61) showed lowest cluster mean.

4.3 Character association

The phenotypic and genotypic correlation coefficients were determined to know the nature of relationship existing between yield and its component characters as well as the association among component character themselves. The results are presented in the Table 20, 21, 22 and 23, 24, 25 for phenotypic and genotypic correlation coefficients, respectively.

4.3.1 Phenotypic correlation among growth, earliness and yield parameters in cucumber genotypes

In *kharif* season (Table 20), fruit yield per vine had positive and highly significant ($p = 0.01$ & $p = 0.05$) association with average fruit weight (0.840), fruit length (0.707), leaf area (0.705), vine length (0.677), circumference of fruit (0.478), internodal length (0.380), number of fruits per vine (0.376) and number of female flowers per vine (0.270). Whereas, days to first male flowering (0.171), number of leaves per vine (0.121), node of first male flower appearance (0.086) and days to first female flowering (0.072) have shown positive non-significant correlation. Negative and significant ($p = 0.05$) association was recorded with number of male flowers per vine (-0.318). Node of first female flower appearance (-0.088) and number of branches per vine (-0.155) exhibited negative and non-significant association.

Vine length was positive and significantly ($p = 0.01$ & $p = 0.05$) correlated with leaf area (0.850), average fruit weight (0.630), internodal length (0.572), days to first male flowering (0.394), days to first female flowering (0.337), circumference of fruit (0.295). While it was negatively and significantly ($p = 0.01$ and $p = 0.05$) correlated with number of male flowers (-0.561) and number of branches per vine (-0.352).

Number of leaves per vine was significantly ($p = 0.01$ and $p = 0.05$), positively associated with number of male flowers per vine (0.703), number of female flowers

Table 20. Phenotypic correlation coefficient among fruit yield per vine and its components in cucumber for *kharif* season

Characters	VL	NOL	NOB	IL	LA	NFMF	NFFF	DFMF	DFFF	NMF	NFF	NF/V	AFW	FL	CF	FY/V
VL	1.000	-0.085	-0.352**	0.572**	0.850**	0.251	-0.149	0.394**	0.337**	-0.561**	-0.057	0.196	0.630**	0.325*	0.295*	0.677**
NOL		1.000	0.633**	-0.299*	0.0238	-0.059	0.391**	-0.383**	-0.327*	0.703**	0.653**	0.540**	-0.1849	0.181	-0.279*	0.121
NOB			1.000	-0.502**	-0.340*	-0.333*	0.229	-0.493**	-0.432**	0.711**	0.608**	0.203	-0.301*	-0.014	-0.367**	-0.155
IL				1.000	0.617**	0.323*	-0.157	0.432**	0.461**	-0.692**	-0.197	-0.053	0.482**	0.323*	0.408**	0.380**
LA					1.000	0.235	0.022	0.389**	0.334**	-0.452**	-0.021	0.224	0.643**	0.459**	0.438**	0.705**
NFMF						1.000	-0.084	0.467**	0.326*	-0.165	-0.214	0.226	-0.012	-0.089	0.085	0.086
NFFF							1.000	-0.281*	-0.244	0.360**	0.340**	0.242	-0.271*	-0.104	-0.309*	-0.088
DFMF								1.000	0.804**	-0.476**	-0.428**	-0.109	0.272*	0.096	0.254*	0.171
DFFF									1.000	-0.489**	-0.445**	-0.156	0.185	0.027	0.109	0.072
NMF										1.000	0.487**	0.284*	-0.517**	-0.184	-0.415**	-0.318*
NFF											1.000	0.428**	0.045	0.308*	-0.162	0.270*
NF/V												1.000	-0.146	-0.091	-0.091	0.376**
AFW													1.000	0.820**	0.619**	0.840**
FL														1.000	0.500**	0.707**
CF															1.000	0.478**
FY/V																1.000

Critical r value 1%=0.330 5%=0.254

*And ** indicate significant at 5 and 1 per cent probability

VL=Vine length (cm),

NOL= Number of leaves @ 90 DAS,

IL=Internodal length (cm),

LA= Leaf area(cm²),

NOB=Number of branches per vine @ 75 DAS

DFMF=Days to first male flowering

DFFF=Days to first female flowering

NFMF=Node of first male flower appearance

NFFF=Node of first female flower appearance

NMF=Number of male flowers per vine

NFF=Number of female flowers per vine

NF/Y=Number of fruits per vine

AFW=Average fruit weight (g)

FL=Fruit length (cm)

CF= circumference of fruit(cm)

FY/V=Fruit yield per vine (kg).

per vine (0.653), number of branches per vine (0.633), number of fruits per vine (0.540) and node of first female flower appearance (0.391). While it was negative and significantly ($p = 0.01$ & $p = 0.05$) correlated with days to first male flowering (-0.383), days to first female flowering (-0.327), internodal length (-0.299) and circumference of fruit (-0.279)

Number of branches per vine had positive significant ($p = 0.01$ & $p = 0.05$) correlation with number of male flowers per vine (0.711) and number of female flowers per vine (0.608). Whereas it was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated with internodal length (-0.502), days to first male flowering (-0.493), days to first female flowering (-0.432), circumference of fruit (-0.367), leaf area (-0.340), node of first male flower appearance (-0.333) and average fruit weight (-0.301).

Internodal length showed highly significant ($p = 0.01$ & $p = 0.05$) positive correlation with leaf area (0.617), average fruit weight (0.482), days to first male flowering (0.432), days to first female flowering (0.461), circumference of fruit (0.408), node of first male flower appearance and fruit length (0.323). Number of male flowers per vine (-0.692) was negative and significantly correlated.

Leaf area was positively and significantly ($p = 0.01$ & $p = 0.05$) associated with average fruit weight (0.643), fruit length (0.459), circumference of fruit (0.438), days to first male flowering (0.389) and days to first female flowering (0.334). Whereas number of male flowers per vine (-0.452) was negative and significantly correlated with this trait.

Node of first male flower appearance was positively and significantly ($p = 0.01$ & $p = 0.05$) interrelated with days to first male flowering (0.467), days to first female flowering (0.326). While positive and non-significantly correlated with fruit yield per vine (0.226).

Node of first female flower appearance showed positive and significant ($p = 0.01$ & $p = 0.05$) correlation with number of male flowers per vine (0.360), number of female flowers per vine (0.340). In contrast it was significant ($p = 0.05$) and negatively correlated with circumference of fruit (-0.309), days to first male flowering (-0.281) and average fruit weight (-0.271).

Days to first male flowering was positive and significantly ($p = 0.01$ & $p = 0.05$) associated with days to first female flowering (0.804), average fruit weight (0.272) and circumference of fruit (0.254). While it had negative and significant ($p = 0.01$ & $p = 0.05$), correlation with number of male flowers per vine (-0.476) and number of female flowers per vine (-0.428).

Days to first female flowering exhibited negative and significant ($p = 0.01$ & $p = 0.05$) association with number of male flowers per vine (-0.489) and number of female flowers per vine (-0.445).

Number of male flowers per vine had significant ($p = 0.01$ & $p = 0.05$) and positive correlation with number of female flowers per vine (0.487) and number of fruits per vine (0.284). Whereas it was negative and significantly ($p = 0.01$ & $p = 0.05$) correlated with average fruit weight (-0.517) and circumference of fruit (-0.415).

Number of female flowers per vine showed positive significant ($p = 0.01$ & $p = 0.05$) interrelation with number of fruits per vine (0.428) and fruit length (0.308).

Average fruit weight was highly positive and significantly ($p = 0.01$ & $p = 0.05$) associated with fruit length (0.820) and circumference of fruit (0.619).

Fruit length had highly significant ($p = 0.01$ & $p = 0.05$) and positive correlation with circumference of fruit (0.500).

In *rabi* season (Table 21), fruit yield per vine exhibited positive and highly significant ($p = 0.01$ & $p = 0.05$) correlation with average fruit weight (0.763), vine length (0.715), leaf area (0.703), fruit length (0.670), number of fruits per vine (0.596), circumference of fruit (0.572), number of female flowers per vine (0.521), number of leaves per vine (0.401) and internodal length (0.376). In contrast node of first male flower appearance (0.190), node of first female flower appearance (0.145) and number of branches per vine (0.019) have shown positive non-significant correlation. Negative and non-significant association was recorded with days to first male flowering (-0.029), days to first female flowering (-0.068) and number of male flowers per vine (-0.138).

Table 21. Phenotypic correlation coefficient among fruit yield per vine and its components in cucumber for *rabi* season

Characters	VL	NOL	NOB	IL	LA	NFMF	NFFF	DFMF	DFFF	NMF	NFF	NF/V	AFW	FL	CF	FY/V
VL	1.000	0.115	-0.226	0.516**	0.860**	0.315*	0.064	0.172	0.261*	-0.491**	0.192	0.352**	0.638**	0.355**	0.429**	0.715**
NOL		1.000	0.570**	-0.147	0.222	0.120	0.486**	-0.341**	-0.369**	0.537**	0.648**	0.645**	-0.029	0.232	-0.018	0.401**
NOB			1.000	-0.321*	-0.131	-0.082	0.360**	-0.384**	-0.412**	0.594**	0.468**	0.468**	-0.359**	-0.116	-0.250	0.019
IL				1.000	0.616**	0.379**	-0.139	0.358**	0.477**	-0.707**	-0.087	0.018	0.487**	0.340**	0.561**	0.376**
LA					1.000	0.305*	0.129	0.179	0.253	-0.448**	0.128	0.331**	0.634**	0.420**	0.493**	0.703**
NFMF						1.000	0.119	0.216	0.273*	-0.236	0.165	0.297*	0.021	-0.117	0.135	0.190
NFFF							1.000	-0.307*	-0.297*	0.344**	0.416**	0.462**	-0.195	-0.060	-0.319*	0.145
DFMF								1.000	0.712**	-0.393**	-0.347**	-0.280*	0.198	-0.064	0.209	-0.029
DFFF									1.000	-0.444**	-0.469**	-0.278*	0.152	-0.100	0.275*	-0.068
NMF										1.000	0.360**	0.293*	-0.445**	-0.160	-0.423**	-0.138
NFF											1.000	0.771**	0.030	0.215	-0.0001	0.521**
NF/V												1.000	0.057	-0.019	-0.031	0.596**
AFW													1.000	0.837**	0.733**	0.763**
FL														1.000	0.640**	0.670**
CF															1.000	0.572**
FY/V																1.000

Critical r value 1%=0.330 5%=0.254

*And ** indicate significant at 5 and 1 per cent probability

VL=Vine length (cm),

NOL= Number of leaves @ 90 DAS,

IL=Internodal length (cm),

LA= Leaf area(cm²),

NOB=Number of branches per vine @ 75 DAS

DFMF=Days to first male flowering

DFFF=Days to first female flowering

NFMF=Node of first male flower appearance

NFFF=Node of first female flower appearance

NMF=Number of male flowers per vine

NFF=Number of female flowers per vine

NF/Y=Number of fruits per vine

AFW=Average fruit weight (g)

FL=Fruit length (cm)

CF= circumference of fruit(cm)

FY/V=Fruit yield per vine (kg).

Vine length was positive and significantly ($p = 0.01$ & $p = 0.05$) correlated with leaf area (0.860), average fruit weight (0.638), internodal length (0.516), circumference of fruit (0.429), fruit length (0.355), number of fruits per vine (0.352), node of first male flower appearance (0.315) and days to first female flowering (0.261). Whereas it was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated with number of male flowers per vine (-0.491).

Number of leaves per vine had significant ($p = 0.01$ & $p = 0.05$) and positive association with number of female flowers per vine (0.648), number of fruits per vine (0.645), number of branches per vine (0.570), number of male flowers per vine (0.537) and node of first female flower appearance (0.486). Whereas it was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated with days to first female flowering (-0.369) and days to first male flowering (-0.341).

Number of branches per vine showed highly significant ($p = 0.01$ & $p = 0.05$) and positive association with number of male flowers per vine (0.594), number of female flowers per vine (0.468), number of fruits per vine (0.468) and node of first female flower appearance (0.360). While it was highly significant ($p = 0.01$ & $p = 0.05$) and negatively correlated with days to first female flowering (-0.412), days to first male flowering (-0.384), average fruit weight (-0.359) and internodal length (-0.321).

Internodal length had highly significant ($p = 0.01$ & $p = 0.05$) and positive interrelation with leaf area (0.616), circumference of fruit (0.561), average fruit weight (0.487), days to first female flowering (0.477), node of first male flower appearance (0.379), days to first male flowering (0.358) and fruit length (0.340). Number of male flowers per vine (-0.707) was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated.

Leaf area was significantly ($p = 0.01$ & $p = 0.05$) and positively associated with average fruit weight (0.634), circumference of fruit (0.493), fruit length (0.420), number of fruits per vine (0.331) and node of first male flower appearance (0.305). Number of male flowers per vine (-0.448) was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated.

Node of first male flower appearance was positive and significantly ($p = 0.01$ & $p = 0.05$) correlated with number of fruits per vine (0.297) and days to first female flowering (0.273).

Node of first female flower appearance showed highly significant ($p = 0.01$ & $p = 0.05$), positive association with number of fruits per vine (0.462), number of female flowers per vine (0.416) and number of male flowers per vine (0.344). While it was highly significant ($p = 0.05$) and negatively correlated with circumference of fruit (-0.319), days to first male flowering (-0.307) and days to first female flowering (-0.297).

Days to first male flowering was positively and significantly ($p = 0.01$ & $p = 0.05$) associated with days to first female flowering (0.712). Whereas number of male flowers per vine (-0.393), number of female flowers per vine (-0.347) and number of fruits per vine (-0.280) had negative significant ($p = 0.01$ & $p = 0.05$) association.

Days to first female flowering depicted negative and significant ($p = 0.01$ & $p = 0.05$) association with number of female flowers per vine (-0.469), number of male flowers per vine (-0.444) and number of fruits per vine (-0.278). While circumference of fruit (0.275) was positive and significantly ($p = 0.05$) correlated.

Number of male flowers per vine was significantly ($p = 0.01$ & $p = 0.05$), positively correlated with number of female flowers per vine (0.360) and number of fruits per vine (0.293). Whereas it was negative and significantly ($p = 0.01$ & $p = 0.05$) correlated with average fruit weight (-0.445) and circumference of fruit (-0.423).

Number of female flowers per vine exhibited significant ($p = 0.01$ & $p = 0.05$) and positive correlation with number of fruits per vine (0.771). Average fruit weight showed positive significant ($p = 0.01$ & $p = 0.05$) association with fruit length (0.837) and circumference of fruit (0.733). Fruit length had positive significant ($p = 0.01$ & $p = 0.05$) correlation with circumference of fruit (0.640).

In pooled average over both the seasons (Table 22), fruit yield per vine showed positive and highly significant ($p = 0.01$ & $p = 0.05$) correlation with average fruit weight (0.824), vine length (0.740), leaf area (0.731), fruit length (0.718),

Table 22. Phenotypic correlation coefficient among fruit yield per vine and its components in cucumber for pooled average over both the seasons

Characters	VL	NOL	NOB	IL	LA	NFMF	NFFF	DFMF	DFFF	NMF	NFF	NF/V	AFW	FL	CF	FY/V
VL	1.000	0.013	-0.332**	0.565**	0.880**	0.322*	-0.007	0.355**	0.333**	-0.546**	0.074	0.316*	0.654**	0.366**	0.413**	0.740**
NOL		1.000	0.634**	-0.234	0.119	0.038	0.504**	-0.397**	-0.403**	0.638**	0.713**	0.658**	-0.108	0.218	-0.176	0.294*
NOB			1.000	-0.468**	-0.270*	-0.227	0.352**	-0.545**	-0.571**	0.734**	0.612**	0.411**	-0.360**	-0.063	-0.366**	-0.070
IL				1.000	0.627***	0.370**	-0.153	0.454**	0.522**	-0.725**	-0.154	-0.017	0.495**	0.347**	0.553**	0.389**
LA					1.000	0.296*	0.086	0.335**	0.317*	-0.461**	0.054	0.309*	0.647**	0.449***	0.505**	0.731**
NFMF						1.000	0.001	0.400**	0.396**	-0.220	-0.068	0.293*	0.001	-0.107	0.113	0.150
NFFF							1.000	-0.363**	-0.322*	0.402**	0.440**	0.385**	-0.250	-0.080	-0.383**	0.021
DFMF								1.000	0.819**	-0.499**	-0.441**	-0.254*	0.290*	0.0476	0.350**	0.083
DFFF									1.000	-0.526**	-0.508**	-0.269*	0.197	-0.030	0.284*	-0.001
NMF										1.000	0.458**	0.313*	-0.497**	-0.182	-0.485**	-0.235
NFF											1.000	0.675**	0.031	0.269*	-0.141	0.424**
NF/V												1.000	-0.100	-0.061	-0.087	0.471**
AFW													1.000	0.844**	0.724**	0.824**
FL														1.000	0.595**	0.718**
CF															1.000	0.581**
FY/V																1.000

Critical r value 1%=0.330 5%=0.254

*And ** indicate significant at 5 and 1 per cent probability

VL=Vine length (cm),

NOL= Number of leaves @ 90 DAS,

IL= Internodal length (cm),

LA= Leaf area(cm²),

NOB=Number of branches per vine @ 75 DAS

DFMF=Days to first male flowering

DFFF=Days to first female flowering

NFMF=Node of first male flower appearance

NFFF=Node of first female flower appearance

NMF=Number of male flowers per vine

NFF=Number of female flowers per vine

NF/Y=Number of fruits per vine

AFW=Average fruit weight (g)

FL=Fruit length (cm)

CF= circumference of fruit(cm)

FY/V=Fruit yield per vine (kg).

circumference of fruit (0.581), number of fruits per vine (0.471), number of female flowers per vine (0.424), internodal length (0.389) and number of leaves per vine (0.294). Node of first male flower appearance (0.150), days to first male flowering (0.083) and node of first female flower appearance (0.021) have shown positive non-significant correlation. Negative and non-significant association was recorded with number of male flowers per vine (-0.235), number of branches per vine (-0.070) and days to first female flowering (-0.001).

Vine length was positive and significantly ($p = 0.01$ & $p = 0.05$) correlated with leaf area (0.880), average fruit weight (0.654), internodal length (0.565), circumference of fruit (0.413), fruit length (0.366), days to first male flowering (0.355) days to first female flowering (0.333), node of first male flower appearance (0.322) and number of fruits per vine (0.316). Whereas it was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated with number of male flowers per vine (-0.546) and number of branches per vine (-0.332).

Number of leaves per vine depicted significant ($p = 0.01$ & $p = 0.05$) and positive association with number of female flowers per vine (0.713), number of fruits per vine (0.658), number of branches per vine (0.634), number of male flowers per vine (0.638), node of first female flower appearance (0.504). Whereas it was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated with days to first female flowering (-0.403) and days to first male flowering (-0.397).

Number of branches per vine was highly significant ($p = 0.01$ & $p = 0.05$) and positively interrelated with number of male flowers per vine (0.734), number of female flowers per vine (0.612), number of fruits per vine (0.411) and node of first female flower appearance (0.352). While it was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated with days to first female flowering (-0.571), days to first male flowering (-0.545), internodal length (-0.468), average fruit weight (-0.360), circumference of fruit (-0.366) and leaf area (-0.270).

Internodal length showed highly significant ($p = 0.01$ & $p = 0.05$) and positive correlation with leaf area (0.627), circumference of fruit (0.553), days to first female flowering (0.522), average fruit weight (0.495), days to first male flowering (0.454), node of first male flower appearance (0.370), days to first male flowering (0.454) and

fruit length (0.347). While number of male flowers per vine (-0.725) was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated with internodal length.

Leaf area recorded significant ($p = 0.01$ & $p = 0.05$) and positive association with average fruit weight (0.647), circumference of fruit (0.505), fruit length (0.449), days to first male flowering (0.335), days to first female flowering (0.317), number of fruits per vine (0.309) and node of first male flower appearance (0.296). Number of male flowers per vine (-0.461) was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated.

Node of first male flower appearance was positive and significantly ($p = 0.01$ & $p = 0.05$) correlated with days to first male flowering (0.400), days to first female flowering (0.396) and number of fruits per vine (0.293).

Node of first female flower appearance manifested highly significant ($p = 0.01$ & $p = 0.05$) positive association with number of female flowers per vine (0.440), number of male flowers per vine (0.402) and number of fruits per vine (0.385). In contrast it was highly significant ($p = 0.01$ & $p = 0.05$) and negatively correlated with circumference of fruit (-0.383), days to first male flowering (-0.363) and days to first female flowering (-0.322).

Days to first male flowering was positive and significantly ($p = 0.01$ & $p = 0.05$) associated with days to first female flowering (0.819), circumference of fruit (0.350) and average fruit weight (0.290). Whereas number of male flowers per vine (-0.499), number of female flowers per vine (-0.441) and number of fruits per vine (-0.254) were negative and significantly ($p = 0.01$ & $p = 0.05$) associated.

Days to first female flowering showed negative and significant ($p = 0.01$ & $p = 0.05$) interrelation with number of male flowers per vine (-0.526), number of female flowers per vine (-0.508) and number of fruits per vine (-0.269). While circumference of fruit (0.284) was positive and significantly ($p = 0.05$) correlated.

Number of male flowers per vine exhibited significant ($p = 0.01$ & $p = 0.05$) and positive correlation with number of female flowers per vine (0.458) and number of fruits per vine (0.313). Whereas it was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated with average fruit weight (-0.497) and circumference of fruit (-0.485).

Number of female flowers per vine was significant ($p = 0.01$ & $p = 0.05$) and positively correlated with number of fruits per vine (0.675) and fruit length (0.269). Average fruit weight had positive significant association ($p = 0.01$ & $p = 0.05$) with fruit length (0.844) and circumference of fruit (0.724). Fruit length had significant ($p = 0.01$ & $p = 0.05$) positive correlation with circumference of fruit (0.595).

4.3.2 Genotypic correlation among growth, earliness and yield parameters in cucumber genotypes

In *kharif* season (Table 23), fruit yield per vine exhibited positive and highly significant ($p = 0.01$ & $p = 0.05$) correlation with average fruit weight (0.883), vine length (0.772), leaf area (0.753), fruit length (0.745), circumference of fruit (0.588), internodal length (0.376), number of fruits per vine (0.287) and number of female flowers per vine (0.275). Days to first male flowering (0.234), days to first female flowering (0.153), node of first male flower appearance (0.136) and number of leaves per vine (0.111) have exhibited positive non-significant correlation. In contrast negative and significant ($p = 0.01$ & $p = 0.05$) association was recorded with number of male flowers per vine (-0.379). Negative and non-significant association with number of branches per vine (-0.189) and node of first female flower appearance (-0.133).

Vine length depicted positive and significant ($p = 0.01$ & $p = 0.05$) correlation with leaf area (0.883), average fruit weight (0.656), internodal length (0.619), days to first female flowering (0.498), days to first male flowering (0.418), fruit length (0.337) and circumference of fruit (0.327). While it was negative and significantly ($p = 0.01$ & $p = 0.05$) correlated with number of male flowers (-0.615) and number of branches (-0.379).

Number of leaves per vine was significant ($p = 0.01$ & $p = 0.05$) and positively associated with number of female flowers per vine (0.758), number of male flowers per vine (0.744), number of branches per vine (0.699), number of fruits per vine (0.624) and node of first female flower appearance (0.610). While it was negative and significantly ($p = 0.01$ & $p = 0.05$) correlated with days to first female flowering (-0.472), days to first male flowering (-0.412), circumference of fruit (-0.352) and internodal length (-0.326).

Table 23. Genotypic correlation coefficient among fruit yield per vine and its components in cucumber for *kharif* season

Characters	VL	NOL	NOB	IL	LA	NFMF	NFFF	DFMF	DFFF	NMF	NFF	NF/V	AFW	FL	CF	FY/V
VL	1.000	-0.117	-0.379**	0.619**	0.883**	0.344**	-0.131	0.418**	0.498**	-0.615**	-0.069	0.238	0.656**	0.337**	0.327*	0.772**
NOL		1.000	0.699**	-0.326*	-0.011	-0.011	0.610**	-0.412**	-0.472**	0.744**	0.758**	0.624**	-0.218	0.165	-0.352**	0.111
NOB			1.000	-0.572**	-0.373**	-0.447**	0.286*	-0.550**	-0.532**	0.779**	0.664**	0.254*	-0.329*	-0.004	-0.421**	-0.189
IL				1.000	0.644**	0.387**	-0.218	0.519**	0.670**	-0.745**	-0.248	-0.118	0.499**	0.333*	0.475**	0.376**
LA					1.000	0.323*	0.080	0.434**	0.403**	-0.485**	-0.007	0.235	0.654**	0.460**	0.503**	0.753**
NFMF						1.000	-0.173	0.678**	0.761**	-0.224	-0.204	0.271*	-0.010	-0.064	-0.048	0.136
NFFF							1.000	-0.470**	-0.302*	0.554**	0.494**	0.328*	-0.309*	-0.034	-0.261*	-0.133
DFMF								1.000	1.028**	-0.517**	-0.500**	-0.097	0.313*	0.122	0.357**	0.234
DFFF									1.000	-0.623**	-0.534**	-0.144	0.244	0.022	0.233	0.153
NMF										1.000	0.520**	0.302*	-0.563**	-0.197	-0.499**	-0.379**
NFF											1.000	0.448**	0.057	0.334*	-0.209	0.275*
NF/V												1.000	-0.181	-0.115	-0.106	0.287*
AFW													1.000	0.835**	0.691**	0.883**
FL														1.000	0.523**	0.745**
CF															1.000	0.588**
FY/V																1.000

Critical r value 1%=0.330 5%=0.254

*And ** indicate significant at 5 and 1 per cent probability

VL=Vine length (cm),

NOL= Number of leaves @ 90 DAS,

IL= Internodal length (cm),

LA= Leaf area(cm²),

NOB=Number of branches per vine @ 75 DAS

DFMF=Days to first male flowering

DFFF=Days to first female flowering

NFMF=Node of first male flower appearance

NFFF=Node of first female flower appearance

NMF=Number of male flowers per vine

NFF=Number of female flowers per vine

NF/Y=Number of fruits per vine

AFW=Average fruit weight (g)

FL=Fruit length (cm)

CF= circumference of fruit(cm)

FY/V=Fruit yield per vine (kg).

Number of branches per vine had positive significant ($p = 0.01$ & $p = 0.05$) correlation with number of male flowers per vine (0.779), number of female flowers per vine (0.664), node of first female flower appearance (0.286) and number of fruits per vine (0.254). In contrast it was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated with internodal length (-0.572), days to first male flowering (-0.550), days to first female flowering (-0.532), circumference of fruit (-0.421), node of first female flower appearance (-0.447), leaf area (-0.373) and average fruit weight (-0.329).

Internodal length was highly significantly ($p = 0.01$ & $p = 0.05$), positively correlated with days to first female flowering (0.670), leaf area (0.644), days to first male flowering (0.519), average fruit weight (0.499), circumference of fruit (0.475), node of first male flower appearance (0.387) and fruit length (0.333). While number of male flowers per vine (-0.745) had negative significant ($p = 0.01$ & $p = 0.05$) correlation.

Leaf area exhibited highly significant ($p = 0.01$ & $p = 0.05$) and positive association with average fruit weight (0.654), circumference of fruit (0.503), fruit length (0.460), days to first male flowering (0.434), days to first female flowering (0.403) and node of first male flower appearance (0.323). Whereas number of male flowers per vine (-0.485) was negative and significantly correlated with the trait.

Node of first male flower appearance showed positive and significant ($p = 0.01$ & $p = 0.05$) interrelation with days to first female flowering (0.761), days to first male flowering (0.678) and number of fruits per vine (0.271).

Node of first female flower appearance had positive and significant ($p = 0.01$ & $p = 0.05$) correlation with number of male flowers per vine (0.554), number of female flowers per vine (0.494) and number of fruits per vine (0.328). Whereas it was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated with days to first male flowering (-0.470), average fruit weight (-0.309), days to first female flowering (-0.302) and circumference of fruit (-0.261).

Days to first male flowering exhibited positive and significant ($p = 0.01$ & $p = 0.05$) association with days to first female flowering (1.028), circumference of fruit (0.357) and average fruit weight (0.313). While it was significantly ($p = 0.01$ & p

= 0.05), negatively correlated with number of male flowers per vine (-0.517) and number of female flowers per vine (-0.500).

Days to first female flowering was negative and significantly ($p = 0.01$ & $p = 0.05$) associated with number of male flowers per vine (-0.623) and number of female flowers per vine (-0.534).

Number of male flowers per vine had significant ($p = 0.01$ & $p = 0.05$) and positive correlation with number of female flowers per vine (0.520) and number of fruits per vine (0.302). Whereas it was significantly ($p = 0.01$ & $p = 0.05$), negatively correlated with average fruit weight (-0.563) and circumference of fruit (-0.499).

Number of female flowers per vine showed significant ($p = 0.01$ & $p = 0.05$) and positive correlation with number of fruits per vine (0.448) and fruit length (0.334).

Average fruit weight depicted highly positive significant ($p = 0.01$ & $p = 0.05$) association with fruit length (0.835) and circumference of fruit (0.691). Fruit length had significant ($p = 0.01$ & $p = 0.05$) positive correlation with circumference of fruit (0.523).

In *rabi* season (Table 24), fruit yield per vine showed positive and highly significant ($p = 0.01$ & $p = 0.05$) correlation with average fruit weight (0.785), vine length (0.771), leaf area (0.746), fruit length (0.713), circumference of fruit (0.710), number of fruits per vine (0.577), number of female flowers per vine (0.549), number of leaves per vine (0.429) and internodal length (0.385). Whereas, node of first male flower appearance (0.164), node of first female flower appearance (0.186) and number of branches per vine (0.085) have shown positive non-significant correlation. In contrast negative and non-significant association was recorded with number of male flowers per vine (-0.158), days to first male flowering (-0.140) and days to first female flowering (-0.077).

Vine length was positive and significantly ($p = 0.01$ & $p = 0.05$) correlated with leaf area (0.896), average fruit weight (0.679), circumference of fruit (0.592), internodal length (0.551), node of first male flower appearance (0.461), fruit length

Table 24. Genotypic correlation coefficient among fruit yield per vine and its components in cucumber for *rabi* season

Characters	VL	NOL	NOB	IL	LA	NFMF	NFFF	DFMF	DFFF	NMF	NFF	NF/V	AFW	FL	CF	FY/V
VL	1.000	0.129	-0.279*	0.551**	0.896**	0.461**	0.077	0.172	0.273*	-0.527**	0.226	0.384**	0.679**	0.388**	0.592**	0.771**
NOL		1.000	0.638**	-0.144	0.195	0.176	0.675**	-0.698**	-0.521**	0.564**	0.785**	0.727**	-0.038	0.233	-0.071	0.429**
NOB			1.000	-0.355**	-0.151	-0.030	0.534**	-0.716**	-0.631**	0.680**	0.591**	0.587**	-0.364**	-0.131	-0.409**	0.085
IL				1.000	0.655**	0.476**	-0.228	0.714**	0.620**	-0.751**	-0.111	0.001	0.506**	0.363**	0.733**	0.385**
LA					1.000	0.439**	0.181	0.284*	0.290*	-0.477**	0.147	0.360**	0.662**	0.430**	0.620**	0.746**
NFMF						1.000	0.202	0.222	0.431**	-0.334**	0.062	0.392**	-0.073	-0.154	0.198	0.164
NFFF							1.000	-0.679**	-0.304*	0.424**	0.511**	0.655**	-0.284*	-0.066	-0.532**	0.186
DFMF								1.000	1.179**	-0.704**	-0.833**	-0.576**	0.307*	0.019	0.751**	-0.140
DFFF									1.000	-0.604**	-0.584**	-0.354**	0.203	-0.140	0.478**	-0.077
NMF										1.000	0.421**	0.341**	-0.487**	-0.183	-0.617**	-0.158
NFF											1.000	0.866**	0.017	0.239	-0.194	0.549**
NF/V												1.000	-0.050	-0.025	-0.029	0.577**
AFW													1.000	0.883**	0.899**	0.785**
FL														1.000	0.686**	0.713**
CF															1.000	0.710**
FY/V																1.000

Critical r value 1%=0.330 5%=0.254

*And ** indicate significant at 5 and 1 per cent probability

VL=Vine length (cm),

NOL= Number of leaves @ 90 DAS,

IL= Internodal length (cm),

LA= Leaf area(cm²),

NOB=Number of branches per vine @ 75 DAS

DFMF=Days to first male flowering

DFFF=Days to first female flowering

NFMF=Node of first male flower appearance

NFFF=Node of first female flower appearance

NMF=Number of male flowers per vine

NFF=Number of female flowers per vine

NF/Y=Number of fruits per vine

AFW=Average fruit weight (g)

FL=Fruit length (cm)

CF= circumference of fruit(cm)

FY/V=Fruit yield per vine (kg).

(0.388), number of fruits per vine (0.384) and days to first female flowering (0.273). Whereas it was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated with number of male flowers per vine (-0.527) and number of branches per vine (-0.279).

Number of leaves per vine had significant ($p = 0.01$ & $p = 0.05$) and positive association with number of female flowers per vine (0.785), number of fruits per vine (0.727), node of first female flower appearance (0.675), number of branches per vine (0.638) and number of male flowers per vine (0.564). Whereas it was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated with days to first male flowering (-0.698) and days to first female flowering (-0.521).

Number of branches per vine showed highly significant ($p = 0.01$ & $p = 0.05$), positive interrelation with number of male flowers per vine (0.680), number of female flowers per vine (0.591), number of fruits per vine (0.587) and node of first female flower appearance (0.534). While it was highly significant ($p = 0.01$ & $p = 0.05$) and negatively correlated with days to first male flowering (-0.716), days to first female flowering (-0.631), circumference of fruit (-0.409), average fruit weight (-0.364) and internodal length (-0.355).

Internodal length exhibited highly significant ($p = 0.01$ & $p = 0.05$) and positive correlation with circumference of fruit (0.733), days to first male flowering (0.714), leaf area (0.655), days to first female flowering (0.620), average fruit weight (0.506), node of first male flower appearance (0.476) and fruit length (0.363). Number of male flowers per vine (-0.715) was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated.

Leaf area depicted significant ($p = 0.01$ & $p = 0.05$) and positive association with average fruit weight (0.662), circumference of fruit (0.620), node of first male flower appearance (0.439), fruit length (0.430), number of fruits per vine (0.360), days to first female flowering (0.290) and days to first male flowering (0.284). Number of male flowers per vine (-0.477) was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated.

Node of first male flower appearance showed positive significant ($p = 0.01$ & $p = 0.05$) correlation with days to first female flowering (0.431) and number of fruits

per vine (0.392). Whereas significant negatively associated with number of male flowers per vine (-0.334).

Node of first female flower appearance had highly significant ($p = 0.01$ & $p = 0.05$), positive association with number of fruits per vine (0.655), number of female flowers per vine (0.511) and number of male flowers per vine (0.424). While it was highly significant ($p = 0.01$ & $p = 0.05$) and negatively interrelated with days to first male flowering (-0.679), circumference of fruit (-0.532), days to first female flowering (-0.304) and average fruit weight (-0.284).

Days to first male flowering was positive and significantly ($p = 0.01$ & $p = 0.05$) associated with days to first female flowering (1.179), circumference of fruit (0.751) and average fruit weight (0.307). Whereas number of female flowers per vine (-0.833), number of male flowers per vine (-0.704), and number of fruits per vine (-0.576) showed negative significant ($p = 0.01$ & $p = 0.05$) association.

Days to first female flowering exhibited negative and significant ($p = 0.01$ & $p = 0.05$) interrelation with number of male flowers per vine (-0.604), number of female flowers per vine (-0.584) and number of fruits per vine (-0.354). While circumference of fruit (0.478) was positive and significantly correlated.

Number of male flowers per vine was significantly ($p = 0.01$ & $p = 0.05$), positively correlated with number of female flowers per vine (0.421) and number of fruits per vine (0.341). Whereas it was significantly ($p = 0.01$ & $p = 0.05$), negatively correlated with circumference of fruit (-0.617) and average fruit weight (-0.487).

Number of female flowers per vine had significant ($p = 0.01$ & $p = 0.05$) and positive correlation with number of fruits per vine (0.866) and fruit length (0.239). Average fruit weight had positive and highly significant association ($p = 0.01$ & $p = 0.05$) with circumference of fruit (0.899) and fruit length (0.883). Fruit length showed significant ($p = 0.01$ & $p = 0.05$) positive interrelation with circumference of fruit (0.686).

In pooled average over both the seasons (Table 25), fruit yield per vine exhibited positive and highly significant ($p = 0.01$ & $p = 0.05$) correlation with

Table 25. Genotypic correlation coefficient among fruit yield per vine and its components in cucumber for pooled average over both the seasons

Characters	VL	NOL	NOB	IL	LA	NFMF	NFFF	DFMF	DFFF	NMF	NFF	NF/V	AFW	FL	CF	FY/V
VL	1.000	0.009	-0.347**	0.588**	0.897**	0.387**	0.0003	0.366**	0.388**	-0.566**	0.083	0.337*	0.668**	0.378**	0.457**	0.779**
NOL		1.000	0.686**	-0.237	0.102	0.064	0.641**	-0.454**	-0.501**	0.650**	0.784**	0.702**	-0.124	0.208	-0.213	0.296*
NOB			1.000	-0.486**	-0.278*	-0.288*	0.390**	-0.645**	-0.712**	0.774**	0.655**	0.451**	-0.365**	-0.058	-0.430**	-0.058
IL				1.000	0.645**	0.406**	-0.214	0.556**	0.670**	-0.746**	-0.188	-0.042	0.505**	0.353**	0.599**	0.388**
LA					1.000	0.353**	0.123	0.388**	0.369**	-0.481**	0.068	0.316*	0.657**	0.452**	0.554**	0.753**
NFMF						1.000	0.005	0.537**	0.620**	-0.248	-0.107	0.306*	-0.022	-0.117	0.079	0.133
NFFF							1.000	-0.498**	-0.323*	0.476**	0.494**	0.491**	-0.309*	-0.072	-0.476**	0.018
DFMF								1.000	1.009**	-0.554**	-0.535**	-0.267*	0.327*	0.0882	0.470**	0.111
DFFF									1.000	-0.622**	-0.544**	-0.295*	0.243	-0.034	0.405**	0.028
NMF										1.000	0.496**	0.337**	-0.522**	-0.193	-0.535**	-0.253
NFF											1.000	0.714**	0.030	0.278*	-0.22	0.431**
NF/V												1.000	-0.112	-0.078	-0.127	0.451**
AFW													1.000	0.857**	0.775**	0.832**
FL														1.000	0.602**	0.729**
CF															1.000	0.608**
FY/V																1.000

Critical r value 1%=0.330 5%=0.254

*And ** indicate significant at 5 and 1 per cent probability

VL=Vine length (cm),

NOL= Number of leaves @ 90 DAS,

IL= Internodal length (cm),

LA= Leaf area(cm²),

NOB=Number of branches per vine @ 75 DAS

DFMF=Days to first male flowering

DFFF=Days to first female flowering

NFMF=Node of first male flower appearance

NFFF=Node of first female flower appearance

NMF=Number of male flowers per vine

NFF=Number of female flowers per vine

NF/Y=Number of fruits per vine

AFW=Average fruit weight (g)

FL=Fruit length (cm)

CF= circumference of fruit(cm)

FY/V=Fruit yield per vine (kg).

average fruit weight (0.832), vine length (0.779), leaf area (0.753), fruit length (0.729), circumference of fruit (0.608), number of fruits per vine (0.451), number of female flowers per vine (0.431), internodal length (0.388) and number of leaves per vine (0.296). Node of first male flower appearance (0.133), days to first male flowering (0.111), days to first female flowering (0.028) and node of first female flower appearance (0.018) have shown positive non-significant correlation. Whereas negative and non-significant association was recorded with, number of branches per vine (-0.058) and number of male flowers per vine (-0.253).

Vine length was positive and significantly ($p = 0.01$ & $p = 0.05$) correlated with leaf area (0.897), average fruit weight (0.668), circumference of fruit (0.457), internodal length (0.588), days to first female flowering (0.388), node of first male flower appearance (0.387), fruit length (0.378), days to first male flowering (0.366) and number of fruits per vine (0.337). In contrast it was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated with number of male flowers per vine (-0.566) and number of branches per vine (-0.347).

Number of leaves per vine had significant ($p = 0.01$ & $p = 0.05$) and positive association with number of female flowers per vine (0.784), number of fruits per vine (0.702), number of branches per vine (0.686), number of male flowers per vine (0.650) and node of first female flower appearance (0.641). Whereas it was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated with days to first female flowering (-0.501) and days to first male flowering (-0.454).

Number of branches per vine showed highly significant ($p = 0.01$ & $p = 0.05$) positive association with number of male flowers per vine (0.774), number of female flowers per vine (0.655), number of fruits per vine (0.451) and node of first female flower appearance (0.390). While it was highly significant ($p = 0.01$ & $p = 0.05$) and negatively interrelated with days to first female flowering (-0.712), days to first male flowering (-0.645), internodal length (-0.486), circumference of fruit (-0.430), average fruit weight (-0.365), node of first male flower appearance (-0.288) and leaf area (-0.278).

Internodal length depicted highly significant ($p = 0.01$ & $p = 0.05$), positive association with days to first female flowering (0.670), leaf area (0.645),

circumference of fruit (0.599), days to first male flowering (0.556), average fruit weight (0.505), node of first male flower appearance (0.406) and fruit length (0.353). Number of male flowers per vine (-0.746) was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated.

Leaf area was significant ($p = 0.01$ & $p = 0.05$) and positively interrelated with average fruit weight (0.657), circumference of fruit (0.554), fruit length (0.452), days to first male flowering (0.388), days to first female flowering (0.369), node of first male flower appearance (0.353) and number of fruits per vine (0.316). Number of male flowers per vine (-0.481) was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated.

Node of first male flower appearance was positive and significantly ($p = 0.01$ & $p = 0.05$) correlated with days to first female flowering (0.620), days to first male flowering (0.537) and number of fruits per vine (0.306).

Node of first female flower appearance had highly significant ($p = 0.01$ & $p = 0.05$), positive association with number of female flowers per vine (0.494), number of fruits per vine (0.491), number of male flowers per vine (0.476). While it was significant ($p = 0.01$ & $p = 0.05$) and negatively correlated with days to first male flowering (-0.498), circumference of fruit (-0.476), days to first female flowering (-0.323) and average fruit weight (-0.309).

Days to first male flowering exhibited positive and significant ($p = 0.01$ & $p = 0.05$) correlation with days to first female flowering (1.009), circumference of fruit (0.470) and average fruit weight (0.327). Whereas number of male flowers per vine (-0.554), number of female flowers per vine (-0.535) and number of fruits per vine (-0.267) showed negative significant ($p = 0.01$ & $p = 0.05$) association.

Days to first female flowering was negative and significantly ($p = 0.01$ & $p = 0.05$) interrelated with number of male flowers per vine (-0.622), number of female flowers per vine (-0.544) and number of fruits per vine (-0.295). While circumference of fruit (0.405) was positive and significantly correlated.

Number of male flowers per vine had significant ($p = 0.01$ & $p = 0.05$) and positive correlation with number of female flowers per vine (0.496), number of fruits

per vine (0.337). Whereas it was significantly ($p = 0.01$ & $p = 0.05$), negatively correlated with average fruit weight (-0.522) and circumference of fruit (-0.535).

Number of female flowers per vine showed significant ($p = 0.01$ & $p = 0.05$) and positive correlation with number of fruits per vine (0.714) and fruit length (0.278).

Average fruit weight had positive significant association ($p = 0.01$ & $p = 0.05$) with fruit length (0.857) and circumference of fruit (0.775). Fruit length had significant ($p = 0.01$ & $p = 0.05$) positive correlation with circumference of fruit (0.602).

4.4 Path coefficient analysis

The result of path coefficient gives relative contribution of different characters towards fruit yield. By partitioning the genotypic and phenotypic correlation coefficient, the direct effect of chosen trait on fruit yield per vine and its indirect effects through other characters are computed and presented in Table 26, 27 and 28 for phenotypic path coefficient. In Table 29, 30 and 31 for genotypic path coefficient.

4.4.1 Phenotypic path analysis

4.4.1.1 Direct effect on fruit yield per vine.

In *kharif* season (Table 26), among all the parameters studied average fruit weight (0.9644) had maximum positive direct effect on fruit yield per vine followed by number of fruits per vine (0.5094), leaf area (0.0628), node of first female flower appearance (0.0264), number of branches per vine (0.0144), number of leaves per vine (0.0095), node of first male flower appearance (0.0092) and fruit length (0.0042). While internodal length (-0.0693), number of male flowers per vine (-0.0641), vine length (-0.0468), number of female flowers per vine (-0.0197), circumference of fruit (-0.0175), days to first female flowering (-0.0135), days to first male flowering (-0.0078) have showed direct negative effect on fruit yield per vine.

In *rabi* season (Table 27), among all the characters studied average fruit weight (0.7903) showed positive direct effect on fruit yield per vine followed by number of fruits per vine (0.6796), fruit length (0.0387), circumference of fruit

Table 26. Phenotypic path coefficient for fifteen yield components on fruit yield per vine in cucumber for *kharif* season

Characters	VL	NOL	NOB	IL	LA	NFMF	NFFF	DFMF	DFFF	NMF	NFF	NF/V	AFW	FL	CF	rP
VL	-0.0468	-0.0008	-0.0051	-0.0397	0.0534	0.0023	-0.0039	-0.0031	-0.0046	0.0360	0.0011	0.1003	0.6085	0.0014	-0.0211	0.677**
NOL	0.0040	0.0095	0.0091	0.0207	0.0015	-0.0005	0.0104	0.0030	0.0044	-0.0450	-0.0129	0.2753	-0.1784	0.0008	0.0200	0.121
NOB	0.0165	0.006	0.0144	0.0348	-0.0217	-0.0031	0.0061	0.0038	0.0059	-0.0456	-0.0120	0.1039	-0.2912	-0.0001	0.0263	-0.155
IL	-0.0268	-0.0028	-0.0072	-0.0693	0.0388	0.0030	-0.0042	-0.0034	-0.0062	0.0443	0.0039	-0.0271	0.4649	0.0014	-0.0292	0.380**
LA	-0.0398	0.0002	-0.005	-0.0428	0.0628	0.0022	0.0006	-0.0030	-0.0045	0.0290	0.0004	0.1144	0.6204	0.0019	-0.0314	0.705**
NFMF	-0.0118	-0.0006	-0.0048	-0.0224	0.0148	0.0092	-0.0022	-0.0036	-0.0044	0.0106	0.0042	0.1156	-0.0121	-0.0004	-0.0061	0.086
NFFF	0.0070	0.0037	0.0033	0.0109	0.0014	-0.0008	0.0264	0.0022	0.0033	-0.0231	-0.0067	0.1237	-0.2613	-0.0004	0.0221	-0.088
DFMF	-0.0185	-0.0036	-0.0071	-0.0300	0.0245	0.0043	-0.0074	-0.0078	-0.0109	0.0306	0.0085	-0.0558	0.2625	0.0004	-0.0182	0.171
DFFF	-0.0158	-0.0031	-0.0062	-0.0320	0.0210	0.0030	-0.0065	-0.0062	-0.0135	0.0313	0.0088	-0.0796	0.1793	0.0001	-0.0079	0.072
NMF	0.0263	0.0067	0.0102	0.0480	-0.0284	-0.0015	0.0095	0.0037	0.0066	-0.0641	-0.0096	0.1448	-0.4994	-0.0008	0.0297	-0.318*
NFF	0.0027	0.0062	0.0087	0.0137	-0.0013	-0.0020	0.0090	0.0033	0.0060	-0.0312	-0.0197	0.2185	0.0436	0.0013	0.0116	0.270*
NF/V	-0.0092	0.0051	0.0029	0.0037	0.0141	0.0021	0.0064	0.0009	0.0021	-0.0182	-0.0085	0.5096	-0.1409	-0.0004	0.0065	0.376**
AFW	-0.0296	-0.0018	-0.0043	-0.0334	0.0404	-0.0001	-0.0072	-0.0021	-0.0025	0.0332	-0.0009	-0.0744	0.9644	0.0035	-0.0443	0.840**
FL	-0.0153	0.0017	-0.0002	-0.0224	0.0288	-0.0008	-0.0028	-0.0007	-0.0004	0.0118	-0.0061	-0.0465	0.7915	0.0042	-0.0358	0.707**
CF	-0.0138	-0.0026	-0.0053	-0.0283	0.0275	0.0008	-0.0082	-0.002	-0.0015	0.0266	0.0032	-0.0465	0.5977	0.0021	-0.0715	0.478**

Residual=0.172

Bold diagonal figure indicate direct effect

rP= Phenotypic correlation coefficient of fruit yield per vine

*And ** indicate significant at 5 and 1 per cent probability

VL=Vine length (cm),

NOL= Number of leaves @ 90 DAS,

IL= Internodal length (cm),

LA= Leaf area(cm²),

NOB=Number of branches per vine @ 75 DAS

DFMF=Days to first male flowering

DFFF=Days to first female flowering

NFMF=Node of first male flower appearance

NFFF=Node of first female flower appearance

NMF=Number of male flowers per vine

NFF=Number of female flowers per vine

NF/Y=Number of fruits per vine

AFW=Average fruit weight (g)

FL=Fruit length (cm)

CF= circumference of fruit(cm)

FY/V=Fruit yield per vine (kg).

Table 27. Phenotypic path coefficient analysis for fifteen yield components on fruit yield per vine in cucumber for *rabi* season

Characters	VL	NOL	NOB	IL	LA	NFMF	NFFF	DFMF	DFFF	NMF	NFF	NF/V	AFW	FL	CF	rP
VL	-0.0258	0.0011	0.0026	0.0174	-0.0002	-0.0006	0.0006	0.0013	0.0017	-0.0081	-0.0050	0.2393	0.5046	0.0137	0.0094	0.715**
NOL	-0.0030	-0.0093	-0.0066	0.0050	-0.0001	-0.0002	0.0044	-0.0026	-0.0024	0.0089	-0.0169	0.4385	-0.0235	0.0090	-0.0004	0.401*
NOB	0.0058	-0.0053	-0.0116	0.0108	0.0000	0.0002	0.0033	-0.0030	-0.0027	0.0098	-0.0122	0.3183	-0.2842	-0.0045	-0.0055	0.019
IL	-0.0133	0.0014	0.0037	-0.0338	-0.0002	-0.0008	-0.0013	0.0028	0.0031	-0.0117	0.0023	0.0124	0.3854	0.0132	0.0123	0.376**
LA	-0.0222	-0.0021	0.0015	-0.0208	-0.0003	-0.0006	0.0012	0.0014	0.0017	-0.0074	-0.0034	0.2253	0.5016	0.0163	0.0108	0.703**
NFMF	-0.0081	-0.0011	0.0010	-0.0128	-0.0001	-0.0020	0.0011	0.0017	0.0018	-0.0039	-0.0043	0.2018	0.0166	-0.0046	0.0030	0.190
NFFF	-0.0017	-0.0045	-0.0042	0.0047	0.0000	-0.0002	0.0090	-0.0024	-0.0019	0.0057	-0.0109	0.3144	-0.1541	-0.0023	-0.0070	0.145
DFMF	-0.0045	0.0032	0.0045	-0.0121	0.0000	-0.0004	-0.0028	0.0077	0.0046	-0.0065	0.0091	-0.1903	0.1566	-0.0025	0.0046	-0.029
DFFF	-0.0067	0.0034	0.0048	-0.0161	-0.0001	-0.0005	-0.0027	0.0055	0.0065	-0.0073	0.0123	-0.1894	0.1207	-0.0039	0.0060	-0.068
NMF	0.0127	-0.005	-0.0069	0.0239	0.0001	0.0005	0.0031	-0.003	-0.0029	0.0165	-0.0094	0.1998	-0.3523	-0.0062	-0.0093	-0.138
NFF	-0.005	-0.006	-0.0054	0.0030	0.0000	-0.0003	0.0038	-0.0027	-0.0031	0.0060	-0.0261	0.5244	0.0238	0.0083	0.0000	0.521**
NF/V	-0.0091	-0.006	-0.0054	-0.0006	-0.0001	-0.0006	0.0042	-0.0022	-0.0018	0.0049	-0.0201	0.6796	-0.0457	-0.0008	-0.0007	0.596**
AFW	-0.0165	0.0003	0.0042	-0.0165	-0.0002	0.0000	-0.0018	0.0015	0.0010	-0.0074	-0.0008	-0.0393	0.7903	0.0324	0.0161	0.763**
FL	-0.0092	-0.0022	0.0013	-0.0115	-0.0001	0.0002	-0.0005	-0.0005	-0.0007	-0.0026	-0.0056	-0.0135	0.6618	0.0387	0.0140	0.670**
CF	-0.0111	0.0002	0.0029	-0.019	-0.0001	-0.0003	-0.0029	0.0016	0.0018	-0.0070	0.0000	-0.021	0.5799	0.0248	0.0219	0.572**

Residual=0.066

Bold diagonal figure indicate direct effect

rP= Phenotypic correlation coefficient of fruit yield per vine

*And ** indicate significant at 5 and 1 per cent probability

VL=Vine length (cm),

NOL= Number of leaves @ 90 DAS,

IL= Internodal length (cm),

LA= Leaf area(cm²),

NOB=Number of branches per vine @ 75 DAS

DFMF=Days to first male flowering

DFFF=Days to first female flowering

NFMF=Node of first male flower appearance

NFFF=Node of first female flower appearance

NMF=Number of male flowers per vine

NFF=Number of female flowers per vine

NF/Y=Number of fruits per vine

AFW=Average fruit weight (g)

FL=Fruit length (cm)

CF= circumference of fruit(cm)

FY/V=Fruit yield per vine (kg).

(0.0219), number of male flowers per vine (0.0165), node of first female flower appearance (0.0090), days to first male flower (0.0077) and days to first female flower (0.0065). Traits like internodal length (-0.0338), number of female flowers per vine (-0.0261), vine length (-0.0258), number of branches per vine (-0.0116), number of leaves per vine (-0.0093), node of first male flower appearance (-0.002) and leaf area (-0.0003) have shown direct negative effect on fruit yield per vine.

In pooled average over both the seasons (Table 28), among all the parameters studied average fruit weight (0.9045) had maximum positive direct effect on fruit yield per vine followed by number of fruits per vine (0.5271), days to first female flowering (0.0309), node of first female flower appearance (0.0272), circumference of fruit (0.0232), number of female flowers per vine (0.0229), number of leaves per vine (0.0146), node of first male flower appearance (0.0123) and leaf area (0.0048). Whereas the direct effect of internodal length (-0.0644), days to first male flowering (-0.0388), fruit length (-0.0118), number of male flowers per vine (-0.0127), number of branches per vine (-0.0074) and vine length (-0.0025) were in negative direction for fruit yield per vine.

4.4.1.2 Indirect effect on fruit yield per vine

In *kharif* season (Table 26), vine length showed indirect positive effect through average fruit weight (0.6085), number of fruits per vine (0.1003) and leaf area (0.0534). Number of leaves per vine had positive indirect effect through number of fruits per vine (0.2753), internodal length (0.0207) and negative indirect effect through average fruit weight (-0.1784). Number of branches per vine has shown positive indirect effect through number of fruits per vine (0.1039), internodal length (0.0348) and circumference of fruit (0.0263). Internodal length had positive indirect effect via average fruit weight (0.4649), number of male flower per vine (0.0443), leaf area (0.0388). Leaf area manifested positive indirect effect via average fruit weight (0.6204), number of fruits per vine (0.1144) and number of male flowers per vine (0.029). Node of first male flower appearance had positive indirect effect through number of fruits per vine (0.1156), leaf area (0.0148) and number of male flowers per vine (0.0106). Node of first female flower appearance had positive indirect effect through number of fruits per vine (0.1237), circumference of fruit (0.0221) and internodal length (0.0109).

Table 28. Phenotypic path coefficient analysis for fifteen yield components on fruit yield per vine in cucumber for pooled average over both the seasons

Characters	VL	NOL	NOB	IL	LA	NFMF	NFFF	DFMF	DFFF	NMF	NFF	NF/V	AFW	FL	CF	rP
VL	-0.0025	0.0002	0.0025	-0.0364	0.0042	0.0040	-0.0002	-0.0138	0.0103	0.0069	0.0017	0.1666	0.5917	-0.0043	0.0096	0.740**
NOL	0.0000	0.0146	-0.0047	0.0151	0.0006	0.0005	0.0137	0.0154	-0.0125	-0.0081	0.0163	0.3472	-0.0978	-0.0026	-0.0041	0.294*
NOB	0.0008	0.0093	-0.0074	0.0302	-0.0013	-0.0028	0.0096	0.0212	-0.0177	-0.0093	0.0140	0.2167	-0.3256	0.0007	-0.0085	-0.070
IL	-0.0014	-0.0034	0.0035	-0.0644	0.0030	0.0046	-0.0042	-0.0176	0.0161	0.0092	-0.0035	-0.0094	0.4483	-0.0041	0.0129	0.389**
LA	-0.0022	0.0017	0.0020	-0.0404	0.0048	0.0036	0.0023	-0.0130	0.0098	0.0059	0.0012	0.1630	0.5857	-0.0053	0.0118	0.731**
NFMF	-0.0008	0.0006	0.0017	-0.0239	0.0014	0.0123	0.0000	-0.0156	0.0122	0.0028	-0.0016	0.1548	0.0017	0.0013	0.0026	0.150
NFFF	0.0000	0.0074	-0.0026	0.0099	0.0004	0.0000	0.0272	0.0141	-0.0100	-0.0051	0.0101	0.2032	-0.2262	0.0010	-0.0089	0.021
DFMF	-0.0009	-0.0058	0.0040	-0.0292	0.0016	0.0049	-0.0099	-0.0388	0.0253	0.0063	-0.0101	-0.1343	0.2623	-0.0006	0.0081	0.083
DFFF	-0.0008	-0.0059	0.0042	-0.0336	0.0015	0.0049	-0.0088	-0.0318	0.0309	0.0067	-0.0116	-0.1419	0.1785	0.0004	0.0066	-0.008
NMF	0.0013	0.0093	-0.0054	0.0467	-0.0022	-0.0027	0.0110	0.0194	-0.0163	-0.0127	0.0105	0.1650	-0.4501	0.0022	-0.0113	-0.235
NFF	-0.0002	0.0105	-0.0045	0.0099	0.0003	-0.0008	0.0120	0.0171	-0.0157	-0.0058	0.0229	0.3561	0.0287	-0.0032	-0.0033	0.424**
NF/V	-0.0008	0.0096	-0.003	0.0011	0.0015	0.0036	0.0105	0.0099	-0.0083	-0.0040	0.0154	0.5271	-0.0908	0.0007	-0.0020	0.471**
AFW	-0.0016	-0.0016	0.0027	-0.0319	0.0031	0.0000	-0.0068	-0.0113	0.0061	0.0063	0.0007	-0.0529	0.9045	-0.0100	0.0168	0.824**
FL	-0.0009	0.0032	0.0005	-0.0224	0.0021	-0.0013	-0.0022	-0.0018	-0.0010	0.0023	0.0062	-0.0325	0.7640	-0.0118	0.0138	0.718**
CF	-0.0010	-0.0026	0.0027	-0.0350	0.0024	0.0014	-0.0104	-0.0136	0.0088	0.0062	-0.0032	-0.0461	0.6557	-0.007	0.0232	0.581**

Residual=0.090

Bold diagonal figure indicate direct effect

rP= Phenotypic correlation coefficient of fruit yield per vine

*And ** indicate significant at 5 and 1 per cent probability

VL=Vine length (cm),

NOL= Number of leaves @ 90 DAS,

IL= Internodal length (cm),

LA= Leaf area(cm²),

NOB=Number of branches per vine @ 75 DAS

DFMF=Days to first male flowering

DFFF=Days to first female flowering

NFMF=Node of first male flower appearance

NFFF=Node of first female flower appearance

NMF=Number of male flowers per vine

NFF=Number of female flowers per vine

NF/V=Number of fruits per vine]

AFW=Average fruit weight (g)

FL=Fruit length (cm)

CF= circumference of fruit(cm)

FY/V=Fruit yield per vine (kg).

Average fruit weight (0.2625), number of male flowers per vine (0.0306) and leaf area (0.0245) showed positive indirect effect by days to first male flowering. Days to first female flowering exhibited indirect positive effect via average fruit weight (0.1793), number of male flowers per vine (0.0313) and leaf area (0.0210). Number of male flowers per vine had indirect positive effect through number of fruits per vine (0.1448), internodal length (0.0480), circumference of fruit (0.0297) and vine length (0.0263). Number of female flowers per vine had indirect positive effect through number of fruits per vine (0.2185), average fruit weight (0.0436) and internodal length (0.0137). Number of fruits per vine has shown positive indirect effect through leaf area (0.0141), circumference of fruit (0.0065), node of first female flower appearance (0.0064) and number of leaves per vine (0.0051). Average fruit weight showed indirect positive effect via leaf area (0.0404), number of male flowers per vine (0.0332) and fruit length (0.0035). Fruit length exhibited positive indirect effect through average fruit weight (0.7915), leaf area (0.0288), number of male flowers per vine (0.0118) and number of leaves per vine (0.0017). Circumference of fruit manifested positive indirect effect through average fruit weight (0.5977), leaf area (0.0275) and number of male flowers per vine (0.0266).

In *rabi* season (Table 27), vine length showed indirect positive effect via average fruit weight (0.5046), number of fruits per vine (0.2393), internodal length (0.0174) and circumference of fruit (0.0094). Number of leaves per vine had positive indirect effect through number of fruits per vine (0.4385), fruit length (0.0090), number of male flower per vine (0.0089) and internodal length (0.0050). Number of branches per vine have showed positive indirect effect through number of fruits per vine (0.3183), internodal length (0.0108), number of male flower per vine (0.0098) and vine length (0.0058). Internodal length exhibited positive indirect effect via average fruit weight (0.3854), fruit length (0.0132), number of fruits per vine (0.0124) and circumference of fruit (0.0123). Leaf area manifested positive indirect effect via average fruit weight (0.5016), number of fruits per vine (0.2253), fruit length (0.0163) and circumference of fruit (0.0108). Node of first male flower appearance had indirect positive effect through number of fruits per vine (0.2018), average fruit weight (0.0166), circumference of fruit (0.0030) and days to first female flowering (0.0018).

Node of first female flower appearance exhibited positive indirect effect through number of fruits per vine (0.3144), internodal length (0.0047) and number of male flowers per vine (0.0057).

Average fruit weight (0.1566), number of female flowers per vine (0.0091), days to first female flowering (0.0046) and circumference of fruit (0.0046) have shown positive indirect effect by days to first male flowering. Days to first female flowering exhibited indirect positive effect through average fruit weight (0.1207), number of female flowers per vine (0.0123), circumference of fruit (0.0060) and days to first male flower (0.0055). Number of male flowers per vine had indirect positive effect through number of fruits per vine (0.1998), internodal length (0.0239) and vine length (0.0127). Number of female flowers per vine depicted indirect positive effect through number of fruits per vine (0.5244), average fruit weight (0.0238), fruit length (0.0083) and number of male flowers per vine (0.0060). Number of fruits per vine have shown positive indirect effect through number of male flowers per vine (0.0049) and node of first female flower appearance (0.0042). Average fruit weight showed indirect positive effect via fruit length (0.0324), circumference of fruit (0.0161) and number of branches per vine (0.0042). Fruit length exhibited positive indirect effect through average fruit weight (0.6618), circumference of fruit (0.0140) and number of branches per vine (0.0013). Circumference of fruit manifested positive indirect effect through average fruit weight (0.5977), fruit length (0.0248), number of branches per vine (0.0029) and days to first female flowering (0.0018).

In pooled average over both the seasons (Table 28), vine length showed indirect positive effect through average fruit weight (0.5917), number of fruits per vine (0.1666), days to first female flowering (0.0103) and circumference of fruit (0.0096). Number of leaves per vine had positive indirect effect through number of fruits per vine (0.3472), number of female flowers per vine (0.0163), day to first male flowering (0.0154) and internodal length (0.0151). Number of branches per vine showed positive indirect effect via number of fruits per vine (0.2167), internodal length (0.0302), days to first male flowering (0.0212) and number of female flowers per vine (0.0140). Internodal length had positive indirect effect via average fruit weight (0.4483), days to first female flowering (0.0161), circumference of fruit

(0.0129) and number of male flower per vine (0.0092). Leaf area manifested positive indirect effect via average fruit weight (0.5857) number of fruits per vine (0.1630), circumference of fruit (0.0118) and days to first female flowering (0.0098). Node of first male flower appearance had indirect positive effect through number of fruits per vine (0.1548), days to first female flowering (0.0122), number of male flowers per vine (0.0028) and circumference of fruit (0.0026). Node of first female flower appearance depicted positive indirect effect via number of fruits per vine (0.2032), days to first male flowering (0.0141), number of female flowers per vine (0.0101) and internodal length (0.0099).

Average fruit weight (0.2623), days to first female flowering (0.0253), circumference of fruit (0.0081) and number of male flowers per vine (0.0063) exhibited positive indirect effect by days to first male flowering. Days to first female flowering showed indirect positive effect through average fruit weight (0.1785), number of male flowers per vine (0.0067), circumference of fruit (0.0066) and node of first male flower appearance (0.0049). Number of male flowers per vine had indirect positive effect through number of fruits per vine (0.1650), internodal length (0.0467), days to first male flowering (0.0194) and number of female flowers per vine (0.0105). Number of female flowers per vine manifested indirect positive effect via number of fruits per vine (0.3561), average fruit weight (0.0287), days to first male flowering (0.0171) and node of first female flower appearance (0.0120). Number of fruits per vine have shown positive indirect effect through number of female flowers per vine (0.0154), node of first female flower appearance (0.0105), days to first male flowering (0.0099) and number of leaves per vine (0.0096). Average fruit weight showed indirect positive effect via circumference of fruit (0.0168), days to first female flowering (0.0061), number of male flowers per vine (0.0063) and leaf area (0.0031). Fruit length exhibited positive indirect effect through average fruit weight (0.7640), circumference of fruit (0.0138), number of female flowers per vine (0.0062) and number of leaves per vine (0.0032). Circumference of fruit manifested positive indirect effect through average fruit weight (0.6557), days to first female flowering (0.0088), number of male flowers per vine (0.0062) and number of branches per vine (0.0027).

4.4.2 Genotypic path analysis

4.4.2.1 Direct effect on fruit yield per vine.

In *kharif* season (Table 29), among all the parameters studied average fruit weight (1.2678) exhibited maximum positive direct effect on fruit yield per vine followed by number of leaves per vine (0.3160), number of fruits per vine (0.2964), node of first male flower appearance (0.2339), number of branches per vine (0.1612), leaf area (0.0841), node of first female flower appearance (0.0822), circumference of fruit (0.0582) and days to first female flowering (0.0422). While number of male flowers per vine (-0.3567), fruit length (-0.2621), internodal length (-0.2519), days to first male flowering (-0.1584), vine length (-0.1336) and number of female flowers per vine (-0.1132) have shown direct negative effect on fruit yield per vine.

In *rabi* season (Table 30), among all the characters studied average fruit weight (0.7269) had positive direct effect on fruit yield per vine followed by number of fruits per vine (0.6854), fruit length (0.0978), vine length (0.0651), days to first male flowering (0.0428), node of first female flower appearance (0.0323), circumference of fruit (0.0319), number of branches per vine (0.0169) and number of male flowers per vine (0.0014). Traits like number of female flowers per vine (-0.0836), leaf area (-0.0593), days to first female flowering (0.0466), internodal length (-0.0318), number of leaves per vine (-0.0222), node of first male flower appearance (-0.0174) have shown direct negative effect on fruit yield per vine.

In pooled average over both the seasons (Table 31), among all the parameters studied average fruit weight (1.0097) depicted maximum positive direct effect on fruit yield per vine followed by number of fruits per vine (0.4922), node of first female flower appearance (0.0600), number of leaves per vine (0.0369), node of first male flower appearance (0.0336), vine length (0.0302), circumference of fruit (0.0281), number of branches per vine (0.0281). Whereas traits like fruit length (-0.0839), leaf area (-0.0530), internodal length (-0.0434), days to first female flowering (-0.0193), number of male flowers per vine (-0.0096), number of female flowers per vine (-0.0096) and days to first male flowering (-0.0040) have shown direct negative effect on fruit yield per vine.

Table 29. Genotypic path coefficient analysis for fifteen yield components on fruit yield per vine in cucumber for *kharif* season

Characters	VL	NOL	NOB	IL	LA	NFMF	NFFF	DFMF	DFFF	NMF	NFF	NF/V	AFW	FL	CF	rG
VL	-0.1336	-0.0372	-0.0612	-0.1559	0.0743	0.0805	-0.0108	-0.0662	0.0210	0.2197	0.0079	0.0706	0.8318	-0.0884	0.0190	0.772**
NOL	0.0157	0.3160	0.1128	0.0821	-0.0010	-0.0026	0.0502	0.0653	-0.0199	-0.2655	-0.0859	0.1852	-0.2772	-0.0434	-0.0205	0.111
NOB	0.0507	0.2212	0.1612	0.1441	-0.0314	-0.1046	0.0235	0.0872	-0.0225	-0.2781	-0.0752	0.0753	-0.4171	0.0011	-0.0245	-0.189
IL	-0.0827	-0.1030	-0.0922	-0.2519	0.0542	0.0906	-0.0180	-0.0822	0.0283	0.2658	0.0281	-0.0352	0.6336	-0.0874	0.0277	0.376**
LA	-0.1180	-0.0036	-0.0603	-0.1622	0.0841	0.0757	0.0066	-0.0688	0.0170	0.1730	0.0009	0.0698	0.8296	-0.1206	0.0293	0.753**
NFMF	-0.0460	-0.0035	-0.0721	-0.0976	0.0272	0.2339	-0.0143	-0.1075	0.0322	0.0800	0.0231	0.0806	-0.0138	0.0169	-0.0028	0.136
NFFF	0.0176	0.1929	0.0461	0.0551	0.0067	-0.0406	0.0822	0.0746	-0.0128	-0.1977	-0.0560	0.0973	-0.3927	0.0090	-0.0152	-0.133
DFMF	-0.0559	-0.1304	-0.0888	-0.1308	0.0365	0.1588	-0.0387	-0.1584	0.0434	0.1845	0.0567	-0.0289	0.3970	-0.0322	0.0208	0.234
DFFF	-0.0665	-0.1493	-0.0858	-0.1689	0.0339	0.1781	-0.0249	-0.1629	0.0422	0.2224	0.0605	-0.0428	0.3093	-0.0059	0.0136	0.153
NMF	0.0822	0.2352	0.1257	0.1877	-0.0408	-0.0525	0.0456	0.0819	-0.0263	-0.3567	-0.0589	0.0897	-0.7145	0.0517	-0.0291	-0.379**
NFF	0.0093	0.2398	0.1071	0.0625	-0.0007	-0.0477	0.0406	0.0793	-0.0226	-0.1857	-0.1132	0.1330	0.0730	-0.0878	-0.0122	0.275*
NF/V	-0.0318	0.1974	0.0410	0.0299	0.0198	0.0636	0.0270	0.0154	-0.0061	-0.1079	-0.0508	0.2964	-0.2304	0.0301	-0.0062	0.287*
AFW	-0.0876	-0.0691	-0.0531	-0.1259	0.0550	-0.0026	-0.0255	-0.0496	0.0103	0.2010	-0.0065	-0.0539	1.2678	-0.2177	0.0402	0.883**
FL	-0.0450	0.0524	-0.0007	-0.0840	0.0387	-0.0151	-0.0028	-0.0195	0.0009	0.0704	-0.0379	-0.0341	1.0529	-0.2621	0.0305	0.745**
CF	-0.0437	-0.1114	-0.0679	-0.1197	0.0423	-0.0114	-0.0215	-0.0565	0.0098	0.1781	0.0237	-0.0315	0.8763	-0.1372	0.0582	0.588**

Residual= 0.091

Bold diagonal figure indicate direct effect

rG= Genotypic correlation coefficient of fruit yield per vine

*And ** indicate significant at 5 and 1 per cent probability

VL=Vine length (cm),

NOL= Number of leaves @ 90 DAS,

IL= Internodal length (cm),

LA= Leaf area(cm²),

NOB=Number of branches per vine @ 75 DAS

DFMF=Days to first male flowering

DFFF=Days to first female flowering

NFMF=Node of first male flower appearance

NFFF=Node of first female flower appearance

NMF=Number of male flowers per vine

NFF=Number of female flowers per vine

NF/Y=Number of fruits per vine

AFW=Average fruit weight (g)

FL=Fruit length (cm)

CF= circumference of fruit(cm)

FY/V=Fruit yield per vine (kg).

Table 30. Genotypic path coefficient analysis for fifteen yield components on fruit yield per vine in cucumber for *rabi* season

Characters	VL	NOL	NOB	IL	LA	NFMF	NFFF	DFMF	DFFF	NMF	NFF	NF/V	AFW	FL	CF	rG
VL	0.0651	-0.0029	-0.0047	-0.0176	-0.0531	-0.0080	0.0025	0.0074	-0.0127	-0.0008	-0.0189	0.2637	0.4939	0.0380	0.0189	0.771**
NOL	0.0084	-0.0222	0.0108	0.0046	-0.0116	-0.0031	0.0218	-0.0299	0.0243	0.0008	-0.0657	0.4985	-0.0281	0.0228	-0.0023	0.429**
NOB	-0.0182	-0.0142	0.0169	0.0113	0.0090	0.0005	0.0173	-0.0307	0.0294	0.0010	-0.0494	0.4029	-0.2651	-0.0128	-0.0131	0.085
IL	0.0360	0.0032	-0.0060	-0.0318	-0.0389	-0.0083	-0.0074	0.0306	-0.0289	-0.0011	0.0093	0.0013	0.3680	0.0355	0.0234	0.385**
LA	0.0584	-0.0043	-0.0026	-0.0209	-0.0593	-0.0076	0.0059	0.0122	-0.0135	-0.0007	-0.0123	0.2474	0.4815	0.0421	0.0198	0.746**
NFMF	0.0301	-0.0039	-0.0005	-0.0152	-0.0260	-0.0174	0.0065	0.0095	-0.0201	-0.0005	-0.0052	0.2691	-0.0533	-0.0151	0.0063	0.164
NFFF	0.0050	-0.0150	0.0090	0.0073	-0.0107	-0.0035	0.0323	-0.0291	0.0142	0.0006	-0.0428	0.4494	-0.2070	-0.0065	-0.0170	0.186
DFMF	0.0113	0.0155	-0.0121	-0.0228	-0.0168	-0.0039	-0.0219	0.0428	-0.0549	-0.0010	0.0697	-0.3951	0.2235	0.0019	0.0240	-0.140
DFFF	0.0178	0.0116	-0.0107	-0.0198	-0.0172	-0.0075	-0.0098	0.0505	-0.0466	-0.0009	0.0488	-0.2430	0.1483	-0.0138	0.0153	-0.077
NMF	-0.0343	-0.0126	0.0115	0.0239	0.0283	0.0058	0.0137	-0.0302	0.0282	0.0014	-0.0352	0.2340	-0.3546	-0.0179	-0.0197	-0.158
NFF	0.0147	-0.0175	0.0100	0.0036	-0.0088	-0.0011	0.0165	-0.0357	0.0272	0.0006	-0.0836	0.5936	0.0124	0.0234	-0.0062	0.549**
NF/V	0.0251	-0.0162	0.0099	-0.0001	-0.0214	-0.0068	0.0212	-0.0247	0.0165	0.0005	-0.0724	0.6854	-0.0364	-0.0025	-0.0009	0.577**
AFW	0.0443	0.0009	-0.0062	-0.0161	-0.0393	0.0013	-0.0092	0.0132	-0.0095	-0.0007	-0.0014	-0.0343	0.7269	0.0864	0.0287	0.785**
FL	0.0253	-0.0052	-0.0022	-0.0116	-0.0255	0.0027	-0.0021	0.0008	0.0066	-0.0003	-0.0200	-0.0175	0.6419	0.0978	0.0219	0.713**
CF	0.0386	0.0016	-0.0069	-0.0234	-0.0368	-0.0034	-0.0172	0.0322	-0.0223	-0.0009	0.0162	-0.0202	0.6532	0.0672	0.0319	0.710**

Residual=0.034

Bold diagonal figure indicate direct effect

rG= Genotypic correlation coefficient of fruit yield per vine

*And ** indicate significant at 5 and 1 per cent probability

VL=Vine length (cm),

NOL= Number of leaves @ 90 DAS,

IL= Internodal length (cm),

LA= Leaf area(cm²),

NOB=Number of branches per vine @ 75 DAS

DFMF=Days to first male flowering

DFFF=Days to first female flowering

NFMF=Node of first male flower appearance

NFFF=Node of first female flower appearance

NMF=Number of male flowers per vine

NFF=Number of female flowers per vine

NF/Y=Number of fruits per vine

AFW=Average fruit weight (g)

FL=Fruit length (cm)

CF= circumference of fruit(cm)

FY/V=Fruit yield per vine (kg).

Table 31. Genotypic path coefficient analysis for fifteen yield components on fruit yield per vine in cucumber for pooled average over both the seasons

Characters	VL	NOL	NOB	IL	LA	NFMF	NFFF	DFMF	DFFF	NMF	NFF	NF/V	AFW	FL	CF	rG
VL	0.0302	0.0004	-0.0098	-0.0255	-0.0475	0.0130	0.0000	-0.0015	-0.0075	0.0055	0.0008	0.1662	0.6752	-0.0317	0.0128	0.779**
NOL	0.0003	0.0369	0.0193	0.0103	-0.0055	0.0022	0.0385	0.0018	0.0097	-0.0063	-0.0076	0.3457	-0.1258	-0.0175	-0.0060	0.296*
NOB	-0.0105	0.0253	0.0281	0.0211	0.0147	-0.0097	0.0234	0.0026	0.0138	-0.0075	-0.0063	0.2222	-0.3690	0.0049	-0.0121	-0.058
IL	0.0178	-0.0088	-0.0137	-0.0434	-0.0342	0.0137	-0.0129	-0.0022	-0.0130	0.0072	0.0018	-0.0210	0.5103	-0.0297	0.0168	0.388**
LA	0.0271	0.0038	-0.0078	-0.0280	-0.0530	0.0119	0.0074	-0.0016	-0.0071	0.0046	-0.0007	0.1556	0.6640	-0.0379	0.0156	0.753**
NFMF	0.0117	0.0024	-0.0081	-0.0176	-0.0187	0.0336	0.0003	-0.0022	-0.0120	0.0024	0.0010	0.1508	-0.0226	0.0098	0.0022	0.133
NFFF	0.0000	0.0237	0.0110	0.0093	-0.0066	0.0002	0.0600	0.0020	0.0062	-0.0046	-0.0048	0.2418	-0.3123	0.0061	-0.0134	0.018
DFMF	0.0111	-0.0168	-0.0181	-0.0242	-0.0206	0.0181	-0.0299	-0.0040	-0.0195	0.0053	0.0052	-0.1315	0.3301	-0.0074	0.0132	0.111
DFFF	0.0118	-0.0185	-0.0200	-0.0291	-0.0196	0.0208	-0.0194	-0.0040	-0.0193	0.0060	0.0052	-0.1454	0.2457	0.0029	0.0114	0.028
NMF	-0.0171	0.0240	0.0218	0.0324	0.0255	-0.0083	0.0286	0.0022	0.0120	-0.0096	-0.0048	0.1662	-0.5271	0.0162	-0.0150	-0.253*
NFF	0.0025	0.0289	0.0184	0.0082	-0.0036	-0.0036	0.0297	0.0021	0.0105	-0.0048	-0.0096	0.3516	0.0309	-0.0233	-0.0063	0.431**
NF/V	0.0102	0.0259	0.0127	0.0019	-0.0168	0.0103	0.0295	0.0011	0.0057	-0.0033	-0.0069	0.4922	-0.1140	0.0066	-0.0036	0.451**
AFW	0.0202	-0.0046	-0.0103	-0.0219	-0.0348	-0.0008	-0.0186	-0.0013	-0.0047	0.0050	-0.0003	-0.0556	1.0097	-0.0719	0.0218	0.832**
FL	0.0115	0.0077	-0.0016	-0.0153	-0.0240	-0.0039	-0.0043	-0.0004	0.0007	0.0019	-0.0027	-0.0387	0.8657	-0.0839	0.0169	0.729**
CF	0.0138	-0.0079	-0.0121	-0.0260	-0.0294	0.0027	-0.0286	-0.0019	-0.0078	0.0052	0.0021	-0.0627	0.7831	-0.0505	0.0281	0.608**

Residual=0.053

Bold diagonal figure indicate direct effect

rG= Genotypic correlation coefficient of fruit yield per vine

*And ** indicate significant at 5 and 1 per cent probability

VL=Vine length (cm),

NOL= Number of leaves @ 90 DAS,

IL= Internodal length (cm),

LA= Leaf area(cm²),

NOB=Number of branches per vine @ 75 DAS

DFMF=Days to first male flowering

DFFF=Days to first female flowering

NFMF=Node of first male flower appearance

NFFF=Node of first female flower appearance

NMF=Number of male flowers per vine

NFF=Number of female flowers per vine

NF/Y=Number of fruits per vine

AFW=Average fruit weight (g)

FL=Fruit length (cm)

CF= circumference of fruit(cm)

FY/V=Fruit yield per vine (kg).

4.4.2.2 Indirect effect on fruit yield per vine

In *kharif* season (Table 29), vine length showed indirect positive effect through average fruit weight (0.8318), number of male flowers per vine (0.2197), number of fruits per vine (0.0706) and leaf area (0.0743). Number of leaves per vine exhibited positive indirect effect through number of fruits per vine (0.1852), number of branches per vine (0.1128), internodal length (0.0821) and days to first male flowering (0.0653). Number of branches per vine have shown positive indirect effect via number of leaves per vine (0.2212), internodal length (0.1441), days to first male flowering (0.0872) and number of fruits per vine (0.0753). Internodal length had positive indirect effect via average fruit weight (0.6336), number of male flowers per vine (0.2658), node of first male flower appearance (0.0906) and leaf area (0.0542). Leaf area manifested positive indirect effect through average fruit weight (0.8296), number of male flowers per vine (0.1730), node of first male flower appearance (0.0757) and number of fruits per vine (0.0698). Node of first male flower appearance exhibited positive indirect effect via number of fruits per vine (0.0806), number of male flowers per vine (0.0800), days to first female flowering (0.0322) and leaf area (0.0272). Node of first female flower appearance had positive indirect effect through number of leaves per vine (0.1929), number of fruits per vine (0.0973), days to first male flowering (0.0746) and internodal length (0.0551).

Days to first male flowering have shown positive association with fruit yield per vine via positive indirect effect of average fruit weight (0.3970), number of male flowers per vine (0.1845), node of first male flower appearance (0.1588) and number of female flowers per vine (0.0567). Days to first female flowering exhibited indirect positive effect through average fruit weight (0.3093), number of male flowers per vine (0.2224), node of first male flower appearance (0.1781) and number of female flowers per vine (0.0605). Number of male flowers per vine manifested indirect positive effect through number of leaves per vine (0.2352), internodal length (0.1877), number of branches per vine (0.1257) and number of fruits per vine (0.0897). Number of female flowers per vine showed indirect positive effect via number of leaves per vine (0.2398), number of fruits per vine (0.1330), number of branches per vine (0.1071) and average fruit weight (0.0730). Number of fruits per vine have shown positive indirect effect through number of leaves per vine (0.1974), node of first male flower

appearance (0.0636), number of branches per vine (0.0410) and fruit length (0.0301). Average fruit weight had indirect positive effect via number of male flowers per vine (0.2010), leaf area (0.0550), circumference of fruit (0.0402) and days to first female flowering (0.0103). Fruit length exhibited positive indirect effect through average fruit weight (1.0529), number of male flowers per vine (0.0704), number of leaves per vine (0.0524) and leaf area (0.0387). Circumference of fruit manifested positive indirect effect via number of male flowers per vine (0.1781), average fruit weight (0.8763), leaf area (0.0423) and number of female flowers per vine (0.0237).

In *rabi* season (Table 30), vine length showed indirect positive effect through average fruit weight (0.4939), number of fruits per vine (0.2637), fruit length (0.0380) and circumference of fruit (0.0189). Number of leaves per vine had positive indirect effect via number of fruits per vine (0.4985), days to first female flowering (0.0243), fruit length (0.0228) and number of branches per vine (0.0108). Number of branches per vine exhibited positive indirect effect through number of fruits per vine (0.4029), days to first female flowering (0.0294), node of first female flower appearance (0.0173) and internodal length (0.0113). Internodal length had positive indirect effect via average fruit weight (0.3680), vine length (0.0360), fruit length (0.0355) and days to first male flowering (0.0306). Leaf area manifested positive indirect effect via average fruit weight (0.4815), number of fruits per vine (0.2474), fruit length (0.0421) and circumference of fruit (0.0198). Node of first male flower appearance showed indirect positive effect through number of fruits per vine (0.2691), vine length (0.0301) and days to first male flowering (0.0095). Node of first female flower appearance had positive indirect effect via number of fruits per vine (0.4494), days to first female flowering (0.0142), number of branches per vine (0.0090) and internodal length (0.0073). Days to first male flowering exhibited positive indirect effect through average fruit weight (0.2235), number of female flowers per vine (0.0697), vine length (0.0113) and number of leaves per vine (0.0155).

Days to first female flowering have shown positive indirect effect through average fruit weight (0.1483), days to first male flowering (0.0505), number of female flowers per vine (0.0488), vine length (0.0178). Number of fruits per vine (0.2340), leaf area (0.0283), days to first female flowering (0.0282), internodal length (0.0239) showed positive indirect effect by means of number of male flowers per vine. Number

of female flowers per vine had indirect positive effect via number of fruits per vine (0.5936), days to first female flowering (0.0272), fruit length (0.0234), vine length (0.0147) and average fruit weight (0.0124). Number of fruits per vine exhibited positive indirect effect through vine length (0.0251), node of first female flower appearance (0.0212), days to first female flowering (0.0165) and number of branches per vine (0.0099). Average fruit weight had indirect positive effect via fruit length (0.0864), vine length (0.0443) and circumference of fruit (0.0287). Fruit length exhibited positive indirect effect through average fruit weight (0.6419), vine length (0.0253), circumference of fruit (0.0219) and days to first female flowering (0.0066). Circumference of fruit manifested positive indirect effect by means of average fruit weight (0.6532), fruit length (0.0672), vine length (0.0386) and days to first female flowering (0.0322).

In pooled average over both the seasons (Table 31), vine length showed indirect positive effect through average fruit weight (0.6752), number of fruits per vine (0.1662), node of first male flower appearance (0.0130) and circumference of fruit (0.0128). Number of leaves per vine had positive indirect effect via number of fruits per vine (0.3457), node of first female flower appearance (0.0385), number of branches per vine (0.0193) and internodal length (0.0103). Number of branches per vine exhibited positive indirect effect through number of fruits per vine (0.2222), number of leaves per vine (0.0253), node of first female flower appearance (0.0234) and internodal length (0.0211). Internodal length had positive indirect effect via average fruit weight (0.5103), vine length (0.0178), circumference of fruit (0.0168) and node of first male flower appearance (0.0137). Leaf area manifested positive indirect effect via average fruit weight (0.6640), number of fruits per vine (0.1556), vine length (0.0271) and circumference of fruit (0.0156). Node of first male flower appearance showed indirect positive effect via number of fruits per vine (0.1508), vine length (0.0117) and fruit length (0.0098). Node of first female flower appearance had positive indirect effect through number of fruits per vine (0.2418), number of leaves per vine (0.0237), number of branches per vine (0.0110) and internodal length (0.0093).

Average fruit weight (0.3301), node of first male flower appearance (0.0181), circumference of fruit (0.0132) and vine length (0.0111) showed positive indirect

effect by means of days to first male flowering. Days to first female flowering exhibited indirect positive effect through average fruit weight (0.2457), node of first male flower appearance (0.0208), vine length (0.0118) and circumference of fruit (0.0114). Number of male flowers per vine showed indirect positive effect through number of fruits per vine (0.1662), internodal length (0.0324), node of first female flower appearance (0.0286) and leaf area (0.0255). Number of female flowers per vine had indirect positive effect via number of fruits per vine (0.3516), average fruit weight (0.0309), node of first female flower appearance (0.0297), number of leaves per vine (0.0289) and days to first female flowering (0.0105). Number of fruits per vine have shown positive indirect effect through node of first female flower appearance (0.0295), number of leaves per vine (0.0259), number of branches per vine (0.0127) and vine length (0.0102). Average fruit weight exhibited indirect positive effect via circumference of fruit (0.0218), vine length (0.0202) and number of male flowers per vine (0.0050). Fruit length exhibited positive indirect effect through average fruit weight (0.8657), circumference of fruit (0.0169), vine length (0.0115) and number of leaves per vine (0.0077). Circumference of fruit manifested positive indirect effect via average fruit weight (0.7831), vine length (0.0138) and number of male flowers per vine (0.0052).

4.5 Pest and disease incidence

4.5.1 Fruit fly incidence

Comparative response of 30 cucumber genotypes for fruit fly infection is presented in Table 32. The fruit fly incidence recorded as percentage of fruits infested ranged from 27.50- 63.47 percent with mean fruit fly infestation of 36.68 percent. The lowest incidence was recorded in HUB-13 (27.50%) and highest in HUB-11 (63.47%).

4.5.2 Downy mildew incidence

Relative response of 30 cucumber genotypes for downy mildew infection is presented in Table 33. The downy mildew incidence recorded as per cent of leaf area ranged from 30.18-51.60 percent with mean 25.52 percent. The lowest incidence was recorded in HUB-30 (30.18%) and highest in HUB-9 (51.60%).

Table 32. Response of cucumber genotypes for fruit fly incidence

Sl. No.	Genotypes	Fruit fly incidence (%)	Score
1	HUB-1	29.53(32.91)	3
2	HUB-2	34.90(36.21)	3
3	HUB-3	29.82(33.10)	3
4	HUB-4	29.71(33.03)	3
5	HUB-5	43.38(41.19)	3
6	HUB-6	35.30(36.45)	3
7	HUB-7	35.50(36.57)	3
8	HUB-8	55.96(48.42)	4
9	HUB-9	59.45(50.45)	4
10	HUB-10	44.48(41.83)	3
11	Long White	32.85(44.97)	3
12	HUB-11	63.47(52.81)	4
13	HUB-12	35.45(36.54)	3
14	Long Green	29.35(32.80)	3
15	HUB-13	27.50(31.63)	3
16	HUB-14	56.00(48.45)	4
17	HUB-15	44.92(42.08)	3
18	HUB-16	31.39(34.07)	3
19	HUB-17	47.04(43.30)	3
20	HUB-18	49.31(44.60)	3
21	HUB-19	42.33(38.25)	3
22	Poona Khira	35.52(36.58)	3
23	HUB-20	46.45(42.97)	3
24	HUB-21	34.57(36.01)	3
25	HUB-22	33.50(35.37)	3
26	Poinsett	40.78(42.00)	3
27	IIHR-264	46.19(42.82)	3
28	IIHR-266	41.91(40.35)	3
29	IIHR-285	35.94(36.83)	3
30	IIHR-303	40.06(39.27)	3
	Mean	36.68	
	SEm±	3.72	
	CD at 5%	10.76	

*Figure in parenthesis are arcsine transformed.

4.5.3 Powdery mildew incidence

Comparative response of different cucumber genotypes for powdery mildew incidence is presented in Table 33. The powdery mildew incidence recorded as per cent of leaf area infested ranged from 14.20- 42.00 percent with mean powdery mildew incidence of 39.62 percent. The lowest (14.20%) incidence was recorded in HUB-2 and highest in HUB-7 (42.00%).

There was no notable infestation of anthracnose in the evaluated genotypes.

4.6 The varietal characterization of cucumber genotypes on DUS test guidelines

Among the 30 genotypes, considerable variation was observed for all the important traits under study. The varietal characterization of cucumber genotypes is presented in Table 34.

4.6.1 Plant growth habit

The thirty genotypes were grouped individually into two categories based upon plant growth habit as determinate, intermediate and indeterminate at 30 days after sowing. Out of thirty all were indeterminate in growing habit.

4.6.2 Plant main vine length

The thirty genotypes were grouped individually into three categories based upon plant vine length. They were measured and recorded as short, intermediate and long. Out of thirty 6 were short, 22 were intermediate and 2 were long genotypes.

4.6.3 Leaf blade orientation

The thirty genotypes were grouped individually into three categories based upon leaf blade orientation as erect, horizontal and drooping. Out of thirty 10 were erect, 19 were horizontal and 1 was drooping.

4.6.4 Leaf blade length

The thirty genotypes were grouped individually into three categories based upon leaf blade length as short, intermediate and long. Out of thirty genotypes 25 were short and 5 were intermediate.

Table 33. Response of cucumber genotypes for powdery and downy mildew incidence

Sl. No.	Genotypes	Powdery mildew incidence (%)	Score	Downy mildew incidence (%)	Score
1	HUB-1	34.50(5.92)	5	14.60(3.89)	2
2	HUB-2	44.50(6.71)	5	14.20(3.83)	2
3	HUB-3	40.30(6.39)	5	17.00(4.18)	2
4	HUB-4	36.50(6.08)	5	29.40(5.47)	3
5	HUB-5	35.40(5.99)	5	26.40(5.19)	3
6	HUB-6	42.20(6.53)	5	37.20(6.14)	3
7	HUB-7	51.50(7.21)	7	42.00(6.52)	3
8	HUB-8	45.60(6.79)	5	28.75(5.41)	3
9	HUB-9	51.60(7.22)	7	27.60(5.30)	3
10	HUB-10	31.40(5.65)	5	25.00(5.05)	2
11	Long White	30.40(5.56)	5	16.60(4.14)	2
12	HUB-11	44.50(6.71)	5	32.80(5.77)	3
13	HUB-12	25.50(5.20)	3	19.60(4.48)	2
14	Long Green	32.30(5.73)	5	17.60(4.25)	2
15	HUB-13	38.60(6.25)	5	26.50(5.20)	3
16	HUB-14	51.30(7.20)	7	37.60(6.17)	3
17	HUB-15	45.20(6.76)	5	34.60(5.92)	3
18	HUB-16	30.20(5.54)	5	16.60(4.14)	2
19	HUB-17	44.60(6.72)	5	33.80(5.86)	3
20	HUB-18	42.30(6.54)	5	30.20(5.54)	3
21	HUB-19	40.80(6.43)	5	26.40(5.19)	3
22	Poona Khira	38.50(6.24)	5	23.50(4.90)	2
23	HUB-20	50.60(7.15)	7	32.50(5.80)	3
24	HUB-21	48.40(6.99)	5	32.00(5.70)	3
25	HUB-22	38.70(6.26)	5	17.60(4.25)	2
26	Poinsett	36.50(6.08)	5	27.50(5.29)	3
27	HUB-23	40.80(6.43)	5	18.60(4.37)	2
28	HUB-24	31.20(5.63)	5	17.60(4.25)	2
29	HUB-25	33.60(5.84)	5	15.30(3.97)	2
30	HUB-26	30.18(5.54)	5	18.30(4.34)	2
	Mean	39.62		25.22	
	SEm±	3.60		3.94	
	CD at 5%	10.41		11.42	

*Figure in parenthesis are square root transformed.

Table 34. Description of morphological DUS descriptors of cucumber genotypes

Sl. No	Genotypes	Morphological characters																			
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	HUB-1	3	5	1	3	9	2	3	1	1	3	5	1	2	4	1	1	3	5	3	5
2	HUB-2	3	5	1	3	9	2	3	1	1	3	5	1	2	4	1	9	3	3	3	5
3	HUB-3	3	5	1	3	9	2	3	1	1	3	5	2	3	4	1	9	3	5	3	7
4	HUB-4	3	5	1	3	1	2	5	1	1	3	5	1	2	3	1	9	3	3	3	7
5	HUB-5	3	5	2	3	9	2	3	1	1	3	5	1	2	4	1	1	3	5	3	7
6	HUB-6	3	3	3	3	9	2	3	1	1	3	5	1	2	3	1	9	3	3	3	7
7	HUB-7	3	5	2	3	9	2	3	1	1	3	5	3	1	3	1	9	3	3	3	5
8	HUB-8	3	3	1	3	9	2	3	1	1	3	5	1	3	4	1	9	5	0	3	5
9	HUB-9	3	5	1	3	9	2	5	1	1	5	5	1	2	3	1	9	3	3	3	7
10	HUB-10	3	5	2	5	9	1	5	1	2	5	5	3	3	4	9	9	7	7	5	5
11	Long White	3	5	2	3	9	1	5	1	2	5	5	3	1	1	1	9	7	7	5	5
12	HUB-11	3	3	2	3	9	1	5	1	1	3	5	2	3	3	1	9	3	3	5	5
13	HUB-12	3	5	2	5	9	2	5	1	1	5	5	3	1	3	9	9	5	0	3	5
14	Long Green	3	7	2	5	9	1	5	1	2	5	5	3	1	3	9	9	7	7	5	5
15	HUB-13	3	5	2	3	9	2	5	1	1	5	5	1	1	4	9	9	5	0	3	5

Contd.....

Sl. No	Genotypes	Morphological characters																			
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
16	HUB-14	3	3	1	3	9	2	5	1	1	3	5	1	2	3	1	1	3	3	3	5
17	HUB-15	3	3	2	3	9	1	5	1	1	3	5	4	2	2	1	9	5	0	3	3
18	HUB-16	3	7	2	5	9	1	5	1	2	5	5	3	3	3	9	9	7	7	5	5
19	HUB-17	3	5	2	3	9	2	5	1	1	3	5	4	2	2	1	9	5	0	3	3
20	HUB-18	3	5	2	3	9	2	5	1	1	5	5	1	2	4	1	9	3	3	3	5
21	HUB-19	3	5	1	3	9	2	5	1	1	3	5	1	2	4	1	9	5	0	3	7
22	Poona Khira	3	5	2	3	9	1	5	1	2	5	5	3	1	4	9	9	7	5	5	5
23	HUB-20	3	3	2	3	9	1	5	1	1	3	5	4	3	3	1	9	3	3	3	3
24	HUB-21	3	5	2	3	9	2	5	1	1	5	5	2	2	4	1	9	3	3	3	7
25	HUB-22	3	5	2	5	9	1	5	1	2	3	5	3	1	3	9	9	7	7	7	7
26	Poinsett	3	5	2	3	9	2	3	1	1	5	5	1	2	4	9	9	3	3	3	7
27	HUB-23	3	5	1	3	9	1	5	1	2	3	5	3	3	3	9	9	7	7	3	5
28	HUB-24	3	5	1	3	9	2	5	1	1	5	5	1	2	4	9	9	3	3	3	7
29	HUB-25	3	5	2	3	9	2	5	1	1	5	5	2	3	4	1	9	3	3	3	7
30	HUB-26	3	5	2	3	9	2	5	1	1	3	5	3	3	3	1	1	3	3	3	5

A- Plant growth habit

B- Plant main vine length

C- Leaf blade orientation

D- Leaf blade length

E- Stem pubescence

F- Stem shape

G- Appearance of first pistillate flower in 50% plant

H- Plant sex expression

I- Ovary colour of vestiture

J- Fruit length

K- Fruit diameter

L- Fruit shape

M- Fruit shape at peduncle end

N- Fruit colour of skin at market stage

O- Fruit ribs

P- Fruit creasing

Q- Fruit type of vestiture hair

S- Seed size

T- Seediness

4.6.5 Stem pubescence

The thirty genotypes were grouped individually into two categories, as absent or present based on presence of pubescence on stem. Out of thirty genotypes pubescence was present on 29 genotypes and absent on 1 genotype.

4.6.6 Stem shape

The thirty genotypes were grouped individually into two categories based upon stem shape as angular or rounded. Out of thirty genotypes 10 were angular shaped and 20 were rounded.

4.6.7 Appearance of first pistillate flower in 50 percent plants

The thirty genotypes were grouped individually into three categories based upon appearance of first pistillate flower as early medium and late. out of thirty genotypes 8 were early and remaining 22 were medium.

4.6.8 Plant sex expression

The thirty genotypes were grouped individually into two categories based upon Plant sex expression as monoecious or gynoecious. In which all thirty genotypes were monoecious.

4.6.9 Ovary colour of vestiture

The thirty genotypes were grouped individually into three categories based upon ovary colour of vestiture as white or black. Out of thirty 7 had black and 23 genotypes had white coloured vestiture.

4.6.10 Parthenocarpy

The thirty genotypes were grouped individually into two categories as absent or present of parthenocarpy. Parthenocarpy was absent in all thirty genotypes.

4.6.11 Fruit length

The thirty genotypes were grouped individually into three categories based upon length of fruit at edible maturity as short, medium and long. Out of thirty 17 were short and remaining 13 were of medium length.

4.6.12 Fruit diameter

The thirty genotypes were grouped individually into three categories based upon diameter as small, medium and large. Among thirty genotypes all thirty were categorised under medium

4.6.13 Fruit shape

The thirty genotypes were grouped individually into three categories based upon Fruit shape as elongate, oblong, cylindrical or oval by visual assessment. Out of thirty 13 were elongate, 4 were oblong, 10 were cylindrical and 3 were oval in shape.

4.6.14 Fruit shape at peduncle end

The thirty genotypes were grouped individually into three categories based upon their fruit shape at peduncle end as flat, acute and obtuse. Among thirty 7 were shaped flat, 14 were acute and 9 were obtuse.

4.6.15 Fruit colour of skin at market stage

The thirty genotypes were grouped individually based upon skin colour at marketable fruit maturity stage and categorized as creamy white, yellow, light green and dark green. Among thirty 1 showed creamy white colour, 2 were yellow, 13 were light green and 14 were dark green in colour.

4.6.16 Fruit ribs

The thirty genotypes were grouped individually into two categories based upon presence or absence of ribs on fruits by visually observing. Out of thirty, ribs were present on 10 genotypes and absent on 20 genotypes.

4.6.17 Fruit creasing

The thirty genotypes were grouped individually into two categories based upon presence or absence of lines or wrinkle on fruit by visual assessment. Out of thirty creasing was present on 26 genotypes and absent on 4 genotypes.

4.6.18 Fruit type of vestiture hair

The thirty genotypes were grouped individually into three categories based upon type of vestiture hair at edible maturity as hairy, non-hairy or prickles. Out of thirty genotypes 17 were hairy, 6 were non-hairy and 7 were prickled.

4.6.19 Fruit density of vestiture

The thirty genotypes were grouped individually into three categories based upon density of vestiture hair on fruit as sparse, medium or dense. Among thirty genotypes 14 had sparse hair, 4 had medium hair and 6 had dense vestiture hair. Others were non-hairy.

4.6.20 Seed size

The thirty genotypes were grouped individually into three categories based upon seed size as small, medium and large. Among thirty 23 were small, 6 were medium and one was large.

4.6.20 Seediness

The thirty genotypes were grouped individually into three categories based upon seed size as low, medium and high. Among thirty 3 genotypes contain small, 16 contain medium and 11 contain high number of seeds per fruit.

5. DISCUSSION

Cucumber is one of the most important cucurbitaceous vegetable crop grown extensively in tropical and sub-tropical parts of the country. In India cucumber can be grown around the year both in open and in protected structures, which becomes an off-season crop for the market fetching remunerative returns to the growers. Realizing this there is need for continuous crop improvement in cucumber which can be achieved by isolating superior breeding lines or varieties having desirable horticultural traits.

Large amount of variation in the germplasm provide better chance of selecting genotypes. Hence, knowledge of the magnitude and kind of variability existing in the germplasm for yield and its attributing traits is important. Heritability examines the extent of heritable portion of variability, while study of genetic advance predicts the possible yield through selection. The yield is a complex character and is dependent on number of yield components. To incorporate desirable yield and quality traits in a variety or hybrid, there is a need to know the inter relationship of different characters. Moreover, knowledge of inter character relationship helps in the identification of important attributes which, in other words, is used to design suitable plant type with improved characters and for multiple trait selection. Path coefficient analysis on the other hand, partitioned the correlation coefficients into direct and indirect effects and the information so generated could be utilized in restructuring desirable plant type. Further, grouping of genotypes based on D^2 analysis is useful in choosing suitable parental lines for heterosis breeding. Such studies are also useful in selection of parents for hybridization to recover superior transgressive segregants, which can be released as improved open pollinated varieties for commercial cultivation.

Therefore, in the present investigation, assessment of variability, characters association, path analysis, genetic divergence for different horticultural traits in cucumber was carried out and the results of experiments are discussed in this chapter.

In this investigation, analysis of variance indicated highly significant variation among the genotypes for all the characters, though difference was very less in majority of cases. This indicated presence of high degree of variation within the genotypes in both *kharif*, *rabi* and also in pooled average over both the seasons.

5.1 Variability studies

5.1.1 Coefficient of variation

Greater variability ensures better chances of producing new desirable forms. Selection is the fundamental process in the development of superior varieties and it depends on the variability available in the crop. Only the genetic proportion of the total variability contributes to gain under selection.

In *kharif* season, high GCV and PCV were observed for number of leaves at 90 DAS, leaf area, internodal length, number of branches per vine, average fruit weight, fruit length, fruit yield per vine, fruit yield per plot and fruit yield per hectare. Whereas moderate GCV and PCV were recorded for vine length, node of first male flower appearance, number of male flowers per vine, number of female flowers per vine, sex ratio, fruit setting per cent, number of fruits per vine, flesh thickness and vitamin-C content. But characters like days to first male flowering, days to first female flowering, node of first female and female flower appearance, circumference of fruit, cavity thickness and total soluble solids recorded low GCV and PCV.

In *rabi* season, high GCV and PCV were observed for vine length, number of leaves at 90 DAS, leaf area, internodal length, number of branches per vine, number of fruits per vine, average fruit weight, fruit length, fruit yield per vine, fruit yield per plot and fruit yield per hectare. Whereas moderate GCV and PCV were recorded for node of first male and female flower appearance, number of male flowers per vine, number of female flowers per vine, fruit setting per cent, flesh thickness and vitamin-C content. Characters like days to first male flowering, days to first female flowering, circumference of fruit, cavity thickness and total soluble solids reported low GCV and PCV. Whereas sex ratio recorded moderate GCV and high PCV.

In pooled average over both the seasons, high GCV and PCV were observed for number of leaves at 90 DAS, leaf area, internodal length, number of branches per vine, average fruit weight, fruit length, fruit yield per vine, fruit yield per plot and fruit yield per hectare. While, moderate GCV and PCV were recorded for vine length, node of first male flower appearance, number of male flowers per vine, number of female flowers per vine, sex ratio, fruit setting per cent, number of fruits per vine,

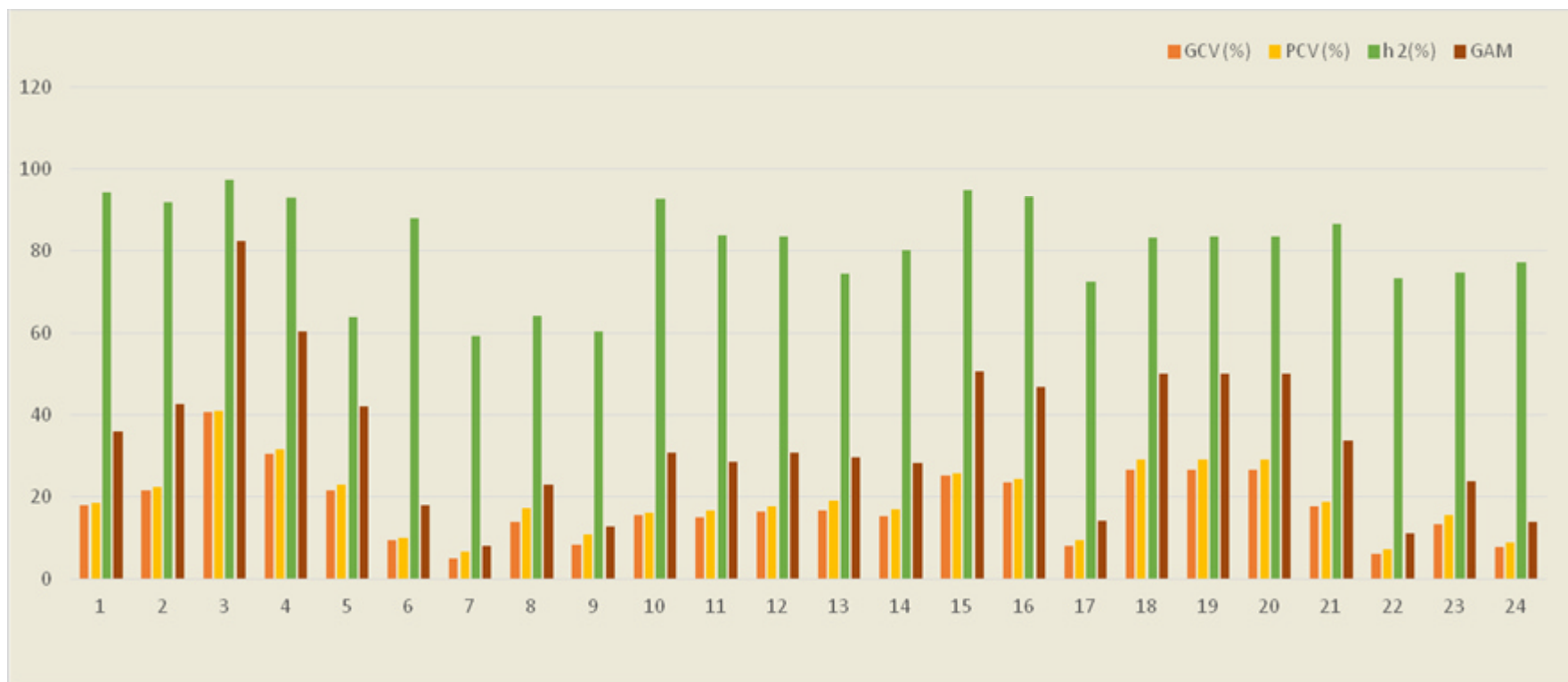


Fig. 1. Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h²) and genetic advance over mean (GAM) for growth, earliness, yield and quality parameters in cucumber (*Kharif* season)

Characters

- | | | | |
|---------------------------------------|--|----------------------------------|------------------------------------|
| 1 = Vine length (cm) | 7 = Days to first female flowering | 13 = Fruit setting percent | 19 = Fruit yield per plot (kg) |
| 2 = Number of leaves @ 90 DAS | 8 = Node of first male flower appearance | 14 = Number of fruits per vine | 20 = Fruit yield per hectare (q) |
| 3 = Internodal length (cm) | 9 = Node of first female flower appearance | 15 = Average fruit weight (g) | 21 = Flesh thickness (mm) |
| 4 = Leaf area (cm ²) | 10 = Number of male flowers per vine | 16 = Fruit length (cm) | 22 = Cavity thickness (mm) |
| 5 = No. of branches per vine @ 75 DAS | 11 = Number of female flowers per vine | 17 = Circumference of fruit (cm) | 23 = Vitamin- C content |
| 6 = Days to first male flowering | 12 = Sex ration | 18 = Fruit yield per vine (kg) | 24 = Total soluble solids (° Brix) |

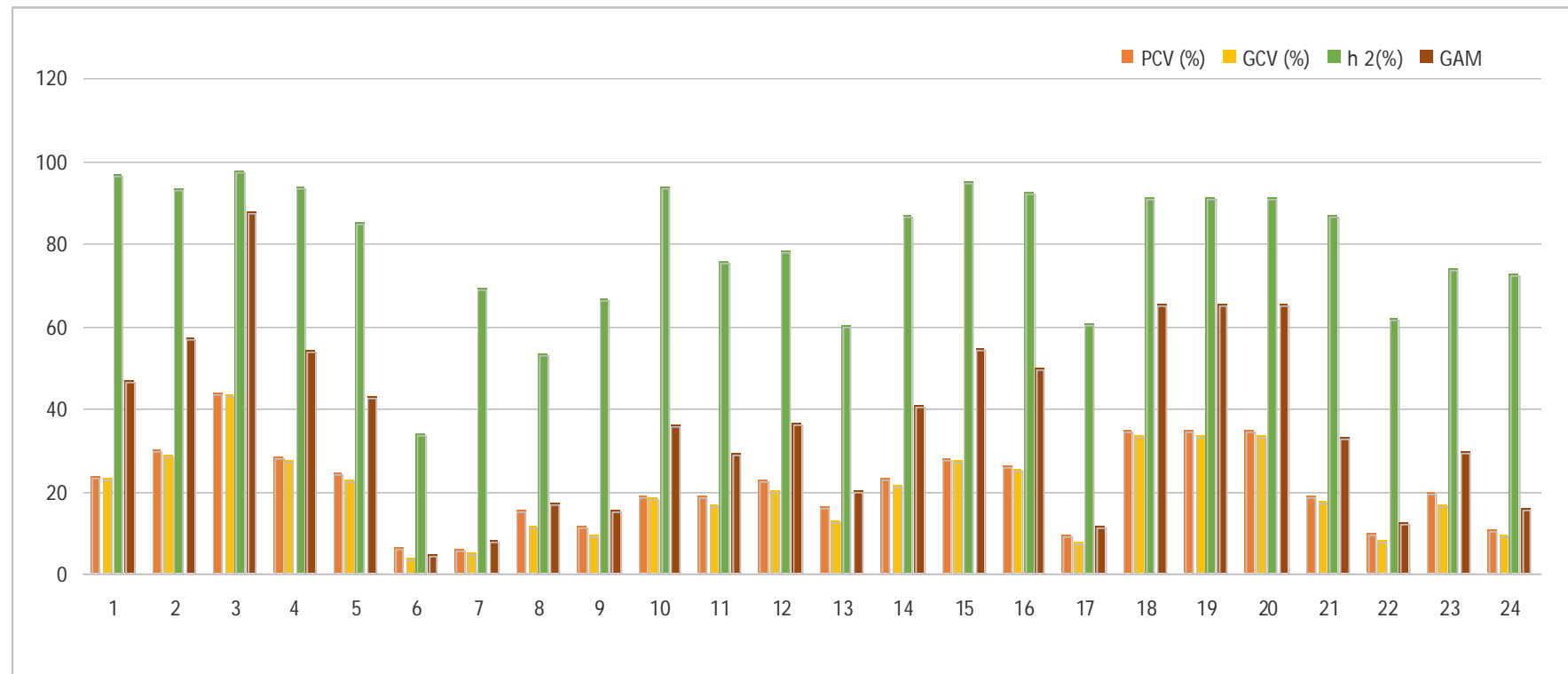


Fig. 2. Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h²) and genetic advance over mean (GAM) for growth, earliness, yield and quality parameters in cucumber (*Rabi* season)

Characters

- | | | | |
|---------------------------------------|--|----------------------------------|------------------------------------|
| 1 = Vine length (cm) | 7 = Days to first female flowering | 13 = Fruit setting percent | 19 = Fruit yield per plot (kg) |
| 2 = Number of leaves @ 90 DAS | 8 = Node of first male flower appearance | 14 = Number of fruits per vine | 20 = Fruit yield per hectare (q) |
| 3 = Internodal length (cm) | 9 = Node of first female flower appearance | 15 = Average fruit weight (g) | 21 = Flesh thickness (mm) |
| 4 = Leaf area (cm ²) | 10 = Number of male flowers per vine | 16 = Fruit length (cm) | 22 = Cavity thickness (mm) |
| 5 = No. of branches per vine @ 75 DAS | 11 = Number of female flowers per vine | 17 = Circumference of fruit (cm) | 23 = Vitamin- C content |
| 6 = Days to first male flowering | 12 = Sex ration | 18 = Fruit yield per vine (kg) | 24 = Total soluble solids (° Brix) |

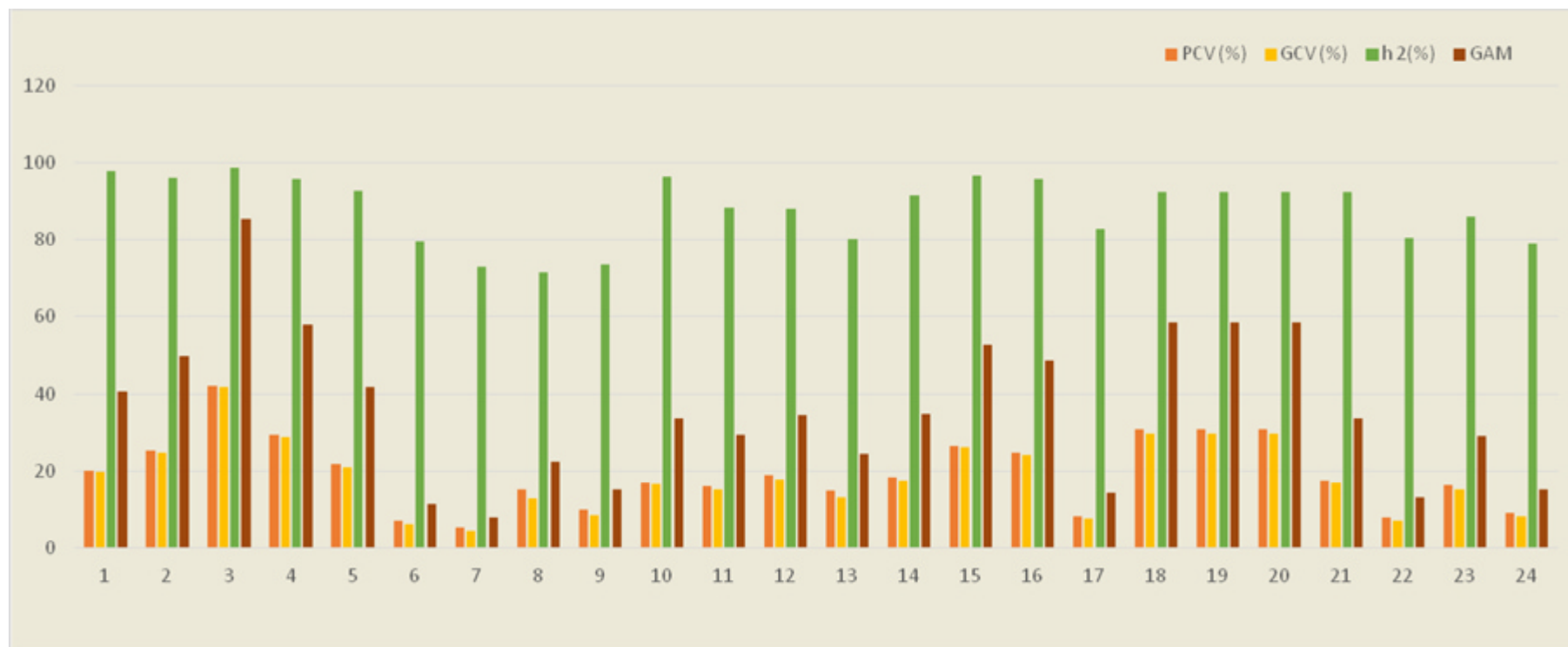


Fig. 3. Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h²) and genetic advance over mean (GAM) for growth, earliness, yield and quality parameters in cucumber (Pooled average both the season)

Characters

- | | | | |
|---------------------------------------|--|----------------------------------|------------------------------------|
| 1 = Vine length (cm) | 7 = Days to first female flowering | 13 = Fruit setting percent | 19 = Fruit yield per plot (kg) |
| 2 = Number of leaves @ 90 DAS | 8 = Node of first male flower appearance | 14 = Number of fruits per vine | 20 = Fruit yield per hectare (q) |
| 3 = Internodal length (cm) | 9 = Node of first female flower appearance | 15 = Average fruit weight (g) | 21 = Flesh thickness (mm) |
| 4 = Leaf area (cm ²) | 10 = Number of male flowers per vine | 16 = Fruit length (cm) | 22 = Cavity thickness (mm) |
| 5 = No. of branches per vine @ 75 DAS | 11 = Number of female flowers per vine | 17 = Circumference of fruit (cm) | 23 = Vitamin- C content |
| 6 = Days to first male flowering | 12 = Sex ration | 18 = Fruit yield per vine (kg) | 24 = Total soluble solids (° Brix) |

flesh thickness and vitamin-C content. But characters like days to first male flowering, days to first female flowering, node of first female flower appearance, circumference of fruit, cavity thickness, total soluble solids recorded low GCV and PCV.

The estimates of phenotypic coefficient of variation were slightly higher than the genotypic coefficient of variation for all the characters studied, though difference was very less in majority of the cases indicating the apparent variation is not only due to genetic but also influenced by environmental factors. Similar results were reported by Veena *et al.* (2012) for vine length, fruit yield per plant and average fruit weight; Kandasamy (2017) for vine length, fruit yield per vine and average fruit weight and days to first female flowering; Afangideh and Uyoh (2007) for number of leaves per vine, fruit yield per vine and fruit length; Ene *et al.* (2016) for number of branches per vine, leaf area and fruit yield per vine; Pushpalatha *et al.* (2016) for fruit yield per vine, average fruit weight, number of branches per vine and internodal length; Basavarajeshwari *et al.* (2012) for days to first male flowering, days to first female flowering and flesh thickness; Ahirwar and Singh (2018) for internodal length, days to first male flowering, days to first female flowering, number of fruits per vine, fruit length and fruit yield per vine; Rajwat and Collis (2017) for number of male flowers per vine, number of female flowers per vine and node of first male flower appearance; Hanchinamani *et al.* (2011) for number of branches per vine, node of first female flower appearance, fruit yield per vine, average fruit weight and fruit length.

5.1.2 Heritability and Genetic advance

Coefficient of variation indicates only the extent of variability present in the germplasm for different characters, but for getting response to selection heritability estimates are useful. Heritability provides information on the degree of inheritance of characters from the parents to the progeny. Very often heritability in broad sense is not true indicator of inheritance of traits, since only additive component of genetic variance is efficiently transferred from generation to generation. Therefore, heritability in broad sense may mislead in judging the effectiveness of selection for the trait. Considering heritability in broad sense along with genetic advance may reveal the prevalence of specific components (additive or non-additive) of genetic

variance for the trait more accurately. High heritability accompanied with high genetic advance indicates the prevalence of additive gene effects and hence, selection would be effective for such characters.

In *kharif* season, high heritability coupled with high genetic advance were observed for vine length, number of leaves at 90 DAS, leaf area, internodal length, number of branches per vine, node of first male flower appearance, number of male flowers per vine, number of female flowers per vine, sex ratio, fruit setting per cent, number of fruits per vine, average fruit weight, fruit length, fruit yield per vine, fruit yield per plot, fruit yield per hectare, flesh thickness and vitamin- C content. Which reveals that variation for these characters is mainly due to action of additive genes and these characters can be improved by selection. High heritability coupled with moderate genetic advance were observed for days to first male flowering, node of first female flower appearance, circumference of fruit, cavity thickness and total soluble solids. Moderate heritability coupled with low genetic advance was observed for days to first female flowering.

In *rabi* season, high heritability coupled with high genetic advance were observed for vine length, number of leaves at 90 DAS, leaf area, internodal length, number of branches per vine, number of male flowers per vine, number of female flowers per vine, sex ratio, number of fruits per vine, average fruit weight, fruit length, fruit yield per vine, fruit yield per plot and fruit yield per hectare, flesh thickness and vitamin- C content. High heritability coupled with moderate genetic advance was observed for node of first female flower appearance, circumference of fruit, cavity thickness and total soluble solids. Days to first male flowering showed moderate heritability and low genetic advance, whereas days to first female flowering showed high heritability and low genetic advance. Node of first male flower appearance and fruit setting per cent had moderate heritability and genetic advance.

In pooled average over both the seasons, high heritability coupled with high genetic advance were observed for vine length, number of leaves at 90 DAS, leaf area, internodal length, number of branches per vine, node of first male flower appearance, number of male flowers per vine, number of female flowers per vine, sex ratio, fruit setting per cent, number of fruits per vine, average fruit weight, fruit length, fruit yield per vine, fruit yield per plot and fruit yield per hectare, flesh

thickness and vitamin- C content. High heritability coupled with moderate genetic advance were observed for days to first male flowering, node of first female flower appearance, circumference of fruit, cavity thickness and total soluble solids. Moderate heritability coupled with low genetic advance was observed for days to first female flowering. Indicating the action of non-additive genes for expression of these characters.

The results are in line with Kandasamy (2017) for vine length, days to first female flowering, node of first male flower appearance, yield per vine, average fruit weight and number of fruits per vine; Kumar *et al.* (2008) for number of branches per vine, number of fruits per vine, fruit length and fruit yield per vine; Arunkumar *et al.* (2011) for number of fruits per vine, days to first male flower, number of female flowers per vine, number of branches vine and vine length; Ahirwar and Singh (2018) for node of first male flower appearance, days to first male flowering, days to first female flowering, vine length and number of fruits per vine; Kumar *et al.* (2017) for number of branches per vine, vitamin- C content and fruit yield per vine; Rajawat and Collis (2017) for number of branches per vine, vine length, average fruit weight and total soluble solids; Shah *et al.* (2017) for node of first male flower appearance, leaf area, fruit length, number of fruits per vine; Ene *et al.* (2016) for vine length, leaf area, number of leaves, days to first male flowering.

5.2 Genetic divergence

The success of breeding programme depends upon the selection of parents. It has been found that the progenies derived from crossing divergent parents give divergent and useful progenies. The D^2 analysis proposed by Mahalanobis (1936) has been reported to be an effective tool to assess the genetic divergence. Such an analysis eventually helps to choose desirable parents for recombination breeding and thus results in the development of superior varieties.

Ecological diversity has been regarded as a reasonable index of genetic diversity (Vavilov, 1926; Moll *et al.* 1962). Assuming this the cultivar from widely separated localities has been included in the hybridization programme by most of the plant breeders for recovering promising segregants. But Sachan and Sharma (1971) could not find any direct relationship between geographic distribution and genetic diversity in crops belonging to different breeding systems.

The 30 cucumber genotypes used in the present study had considerable diversity as implied by the magnitude of all possible D^2 values which ranged from 219.21 to 2532.09 in *kharif* season, 273.14 to 4692.32 in *rabi* season and 263.81 to 6818.97 in pooled average both the seasons. Thirty genotypes were grouped into 8 clusters in *kharif* season, maximum number of genotypes were accommodated in the cluster I (12) followed by cluster II (1), cluster III (5), cluster IV (4), cluster V (5), cluster VI (1), cluster VII (1) and cluster VIII (1). In *rabi* season, they were grouped into 7 clusters, maximum number of genotypes were accommodated in the cluster I (15) followed by cluster II (5), cluster III (4), cluster IV (1), cluster V (3), cluster VI (1) and cluster VII (1). They were grouped into 10 clusters in pooled average both the seasons based on D^2 values. Maximum number of genotypes were accommodated in the cluster I (12) followed by cluster II (4), cluster III (3), cluster IV (1), cluster V (1), cluster VI (4), cluster VII (1), cluster VIII (1), cluster IX (2) and cluster X (1).

In *kharif* season, the intra cluster distance was found maximum in cluster V (387.92) indicating that the genotypes belonging to cluster V are closely related followed by cluster IV (296.64) and cluster III (221.41). In *rabi* season, the intra cluster distance was found maximum in cluster V (375.58) followed by cluster III (334.77) and cluster II (311.58). In pooled average over both the season, the intra cluster distance was found maximum in cluster II (320.94) closely followed by cluster III (307.84) and cluster IX (274.51) this indicates good scope for selection within the cluster. Intra cluster distances being much smaller than inter cluster distances, indicates homogenous and heterogenous nature of genotypes within and between the clusters, respectively.

Based on distance between clusters *i.e.* inter cluster distance, maximum divergence was observed between cluster II and III (2532.09) closely followed by cluster III and VI (2423.17), cluster III and VII (2405.04). The least inter cluster distance was observed between cluster VI and VII (244.6) in *kharif* season. In *rabi* season, maximum inter cluster distance was recorded between cluster II and VI (4692.32) closely followed by cluster I and II (3432.5) and cluster II and V (3126.31). The least inter cluster distance was observed between cluster IV and V (224.18). In pooled average over both the season, highest inter cluster distance was recorded between cluster III and VI (6818.97) closely followed by cluster IV and VII.

(6713.33) and cluster 1 and VII (5618.69). The least inter-cluster distance was observed among cluster IV and VIII (459.33).

Such diverse genotypes categorized by maximum inter cluster distance will differ in phenotypic performance and therefore, to obtain higher heterosis and superior segregants select the superior genotypes from these clusters on the basis of result obtained. Similar divergence studies were conducted by using D^2 analysis by Sharma and Sharma (2006) and Sharma *et al.* (2018B) in cucumber using thirty genotypes. Resmi and Sreelathakumary (2012) and Singh *et al.* (2013) in bitter gourd.

5.2.1 Per cent contribution to diversity

In *kharif* season, among the 21 traits studied fruit yield per vine contributed maximum to the genetic diversity among the characters followed by fruit length, fruit yield per plot, cavity thickness, leaf area, flesh thickness, circumference of fruit, internodal length, days to first male flowering, average fruit weight, node of first female flower appearance, number of male flowers per vine and fruit setting per cent.

In *rabi* season, circumference of fruit contributed maximum to the genetic diversity among all the characters followed by leaf area, flesh thickness, fruit yield per vine, fruit setting per cent, fruit length, average fruit weight, fruit yield per vine, cavity thickness, number of fruits per vine, number of male flowers per vine, sex ratio, number of leaves per vine and internodal length.

In pooled average over both the seasons, leaf area contributed maximum to the genetic diversity among the parameters followed by fruit yield per vine, cavity thickness, fruit length, circumference of fruit, fruit setting per cent, sex ratio, number of female flowers per vine, number of fruits per vine, average fruit weight, number of leaves per vine, internodal length, number of male flowers per vine, vine length, number of branches per vine, node of first female flower appearance, days to first male flowering and flesh thickness.

Hence, apart from selecting genotypes from clusters which have higher inter cluster distance for hybridization, one can also think of selecting parents based on extent of genetic divergence in respect to particular trait of interest. Comparable results were found by Ara *et al.* (2014) in bitter gourd.

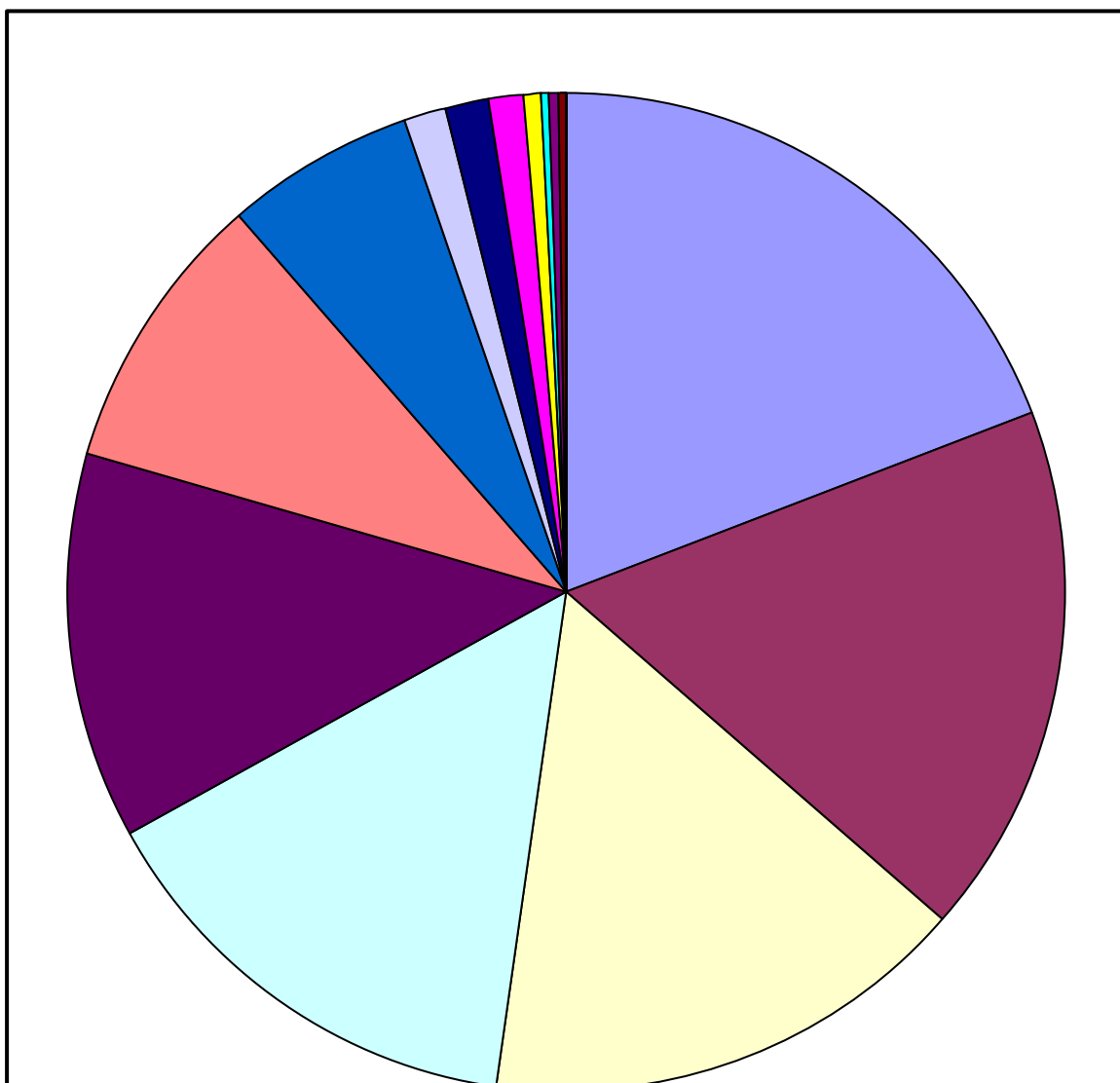
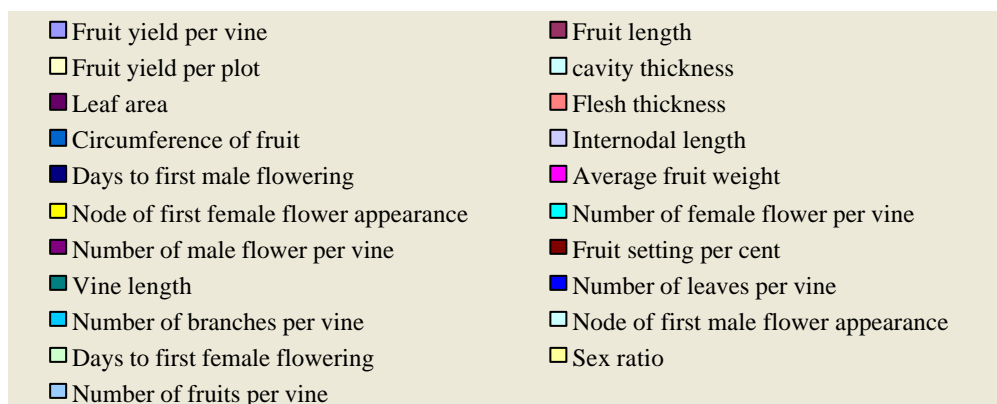
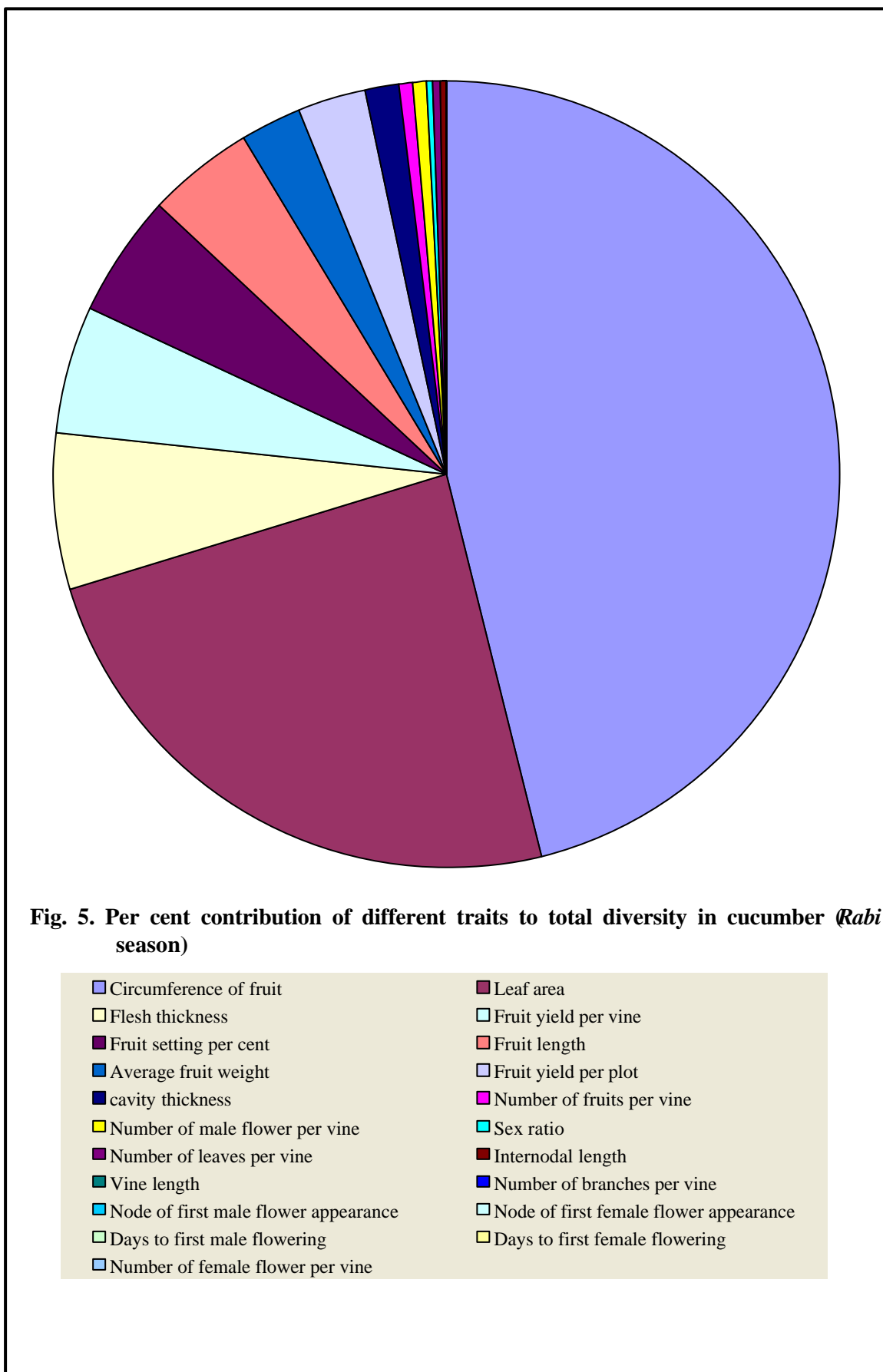
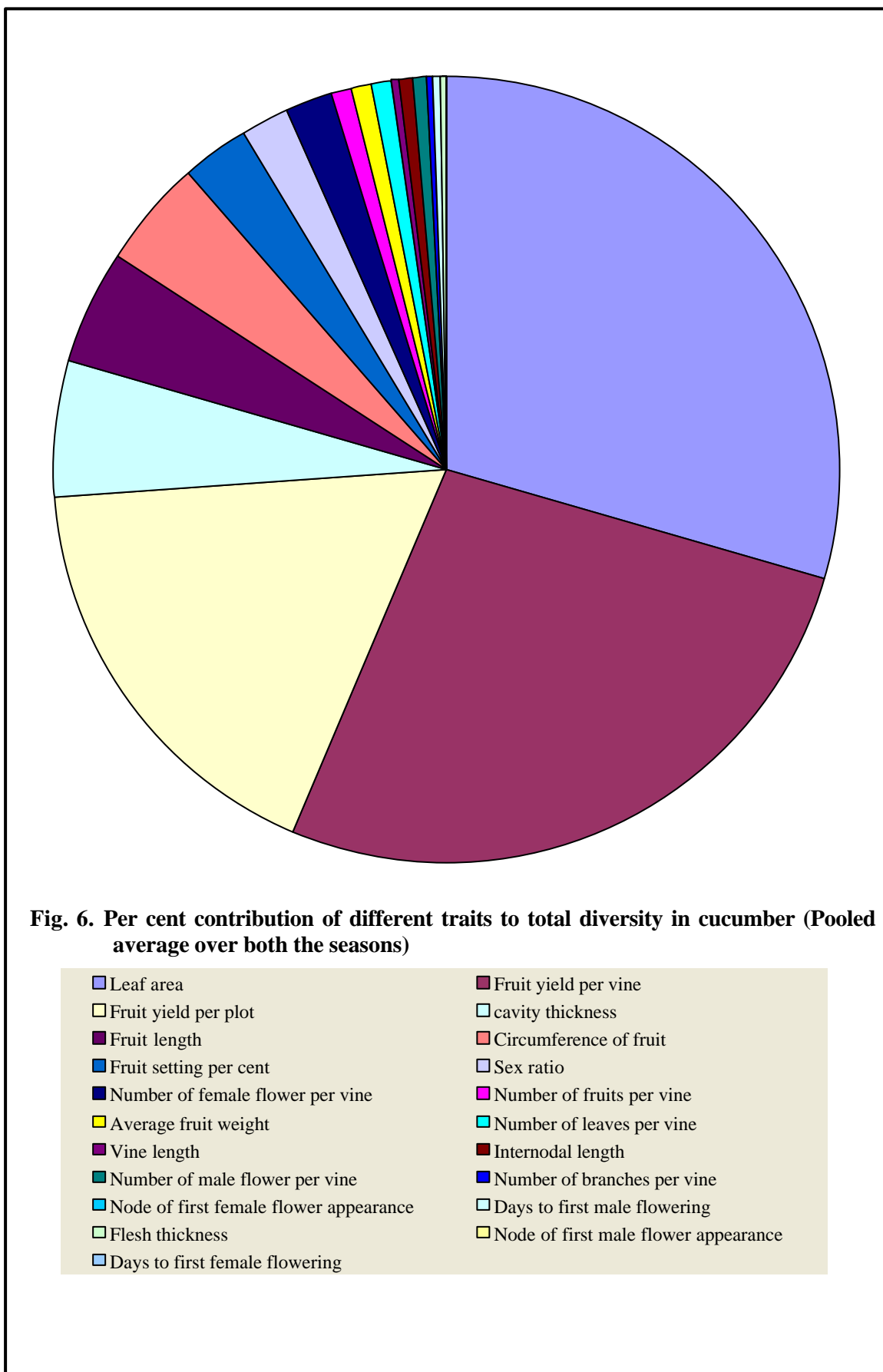


Fig. 4. Per cent contribution of different traits to total diversity in cucumber (*kharif* season)







5.2.2 Analysis of cluster means

All genotypes spread over clusters and means were scored across the clusters for all the characters. The highest cluster mean was given the first rank next cluster possessing next best means were given 2nd, 3rd and so on up to last rank for all the traits except node of first male flower appearance, node of first female flower appearance, days to first male flowering and days to first female flowering where lowest values were given first rank and highest values were ranked last.

In *kharif* season, cluster V with overall score of 70 across 21 characters secured first rank followed by cluster I, cluster VIII, cluster III, cluster IV, cluster II, cluster IV and cluster VII. In *rabi* season, cluster VI with overall score of 58 among 21 characters secured first rank followed by cluster III, cluster II, cluster I, cluster VII, cluster IV and cluster V. In pooled average over both the seasons, cluster VI with overall score of 86 secured first rank followed by cluster II, cluster III, cluster IX, cluster I, cluster VII, cluster X, cluster VI, cluster VIII and cluster IV. This indicating the presence of most promising genotypes in clusters ranked high and it can be extensively used for further breeding programme to generate new material.

The results are in line with divergence studies by Singh *et al.* (2013) in bitter gourd, Hasan *et al.* (2015) and Sharma *et al.* (2018B) in cucumber.

5.3 Character association

Knowledge of degree of association of yield with its components is of great importance, because yield is not an independent character and it is resultant of interaction of a number of component characters. Correlation provides information on the nature and extent of association between characters in a population. When selection pressure is applied on a trait, the population under selection is improved not only for that trait but also for other characters associated with it. This facilitates simultaneous improvement of two or more characters. Therefore, analysis of yield in terms of phenotypic and genotypic correlation coefficients of component characters helps in understanding characters that can form the basis of selection.

In the present study genotypic and phenotypic correlation coefficient were worked out for growth and yield components and heritability for both genotypic and

phenotypic association have been discussed. A narrow difference between the estimates of genotypic and phenotypic correlation were observed for various traits and this indicates lesser influence of environment in the expression of these traits and presence of strong inherent association among the traits. Correlations among traits are discussed here under.

In *kharif* season, fruit yield per vine exhibited positive and significant genotypic and phenotypic correlation with average fruit weight, vine length, leaf area, fruit length, circumference of fruit, internodal length, number of fruits per vine and number of female flowers per vine. Negative and significant association was recorded with number of male flowers per vine.

In *rabi* season fruit yield per vine had positive and highly significant correlation with average fruit weight, vine length, leaf area, fruit length, number of fruits per vine, circumference of fruit, number of female flowers per vine, number of leaves per vine and internodal length at both genotypic and phenotypic level.

In pooled average over both the season, fruit yield per vine showed significant positive genotypic and phenotypic correlation with average fruit weight, vine length, leaf area, fruit length, circumference of fruit, number of fruits per vine, number of female flowers per vine, internodal length and number of leaves per vine.

These findings are in agreement with Dhiman and Prakash (2005) for number of fruits per vine, average fruit weight, and fruit length; Hanchinamani and Patil (2008) for number of fruits per vine, number of primary branches per vine, fruit length, fruit diameter, vine length and internodal length; Ullah *et al.* (2012) for number of fruits per vine, average fruit weight and number of leaves per vine; Arunkumar *et al.* (2011) for number of fruits per vine, average fruit weight, fruit length, fruit diameter, number of primary branches per vine and vine length; Ene *et al.* (2016) for vine length, number of branches per vine, number of leaves per vine, leaf area, number of pistillate flowers per vine, number of fruits per vine, fruit length, fruit girth and fruit weight.

The results of present study concluded that most important positive characters contributing towards yield per plant at genotypic level were average fruit weight, vine length, leaf area, fruit length, circumference of fruit, number of fruits per vine and

number of female flowers per vine, suggesting that selection procedure applied for increasing these traits will help in eventually increasing the yield.

5.4 Path analysis

Though correlation analysis indicates the association pattern of component traits with yield, they simply represent the overall influence of trait on yield rather than providing cause and effect relationship. The technique of path coefficient analysis developed by Wright (1921) and demonstrated by Dewey and Lu (1959) facilitates the partitioning of correlation coefficients into direct and indirect contribution of various characters on yield. It is standardized partial regression coefficient analysis as such, it measures the direct influence of variable upon the others. Such information would be great value in enabling the breeder to specifically select important component traits of yield and utilize the genetic stock for improvement in a planned way. In the present study path coefficient analysis between the components of cucumber yield was worked out.

In *kharif* season, path coefficient analysis at both genotypic and phenotypic level revealed that average fruit weight showed maximum positive direct effect on fruit yield per vine followed by number of fruits per vine, leaf area, node of first female flower appearance, number of branches per vine, number of leaves per vine, days to first female flowering, node of first male flower appearance and circumference of fruit. Whereas in phenotypic level fruit length also showed positive direct effect and days to first female flowering had negative direct effect on fruit yield per vine.

In *rabi* season, path coefficient analysis at genotypic level revealed that average fruit weight exhibited positive direct effect on fruit yield per vine followed by number of fruits per vine, fruit length, vine length, days to first male flowering, node of first female flower appearance, circumference of fruit, number of branches per vine and number of male flowers per vine. At phenotypic level average fruit weight had positive direct effect on fruit yield per vine followed by number of fruits per vine, fruit length, circumference of fruit, number of male flowers per vine, node of first male flower appearance, days to first male flowering and days to first female flowering.

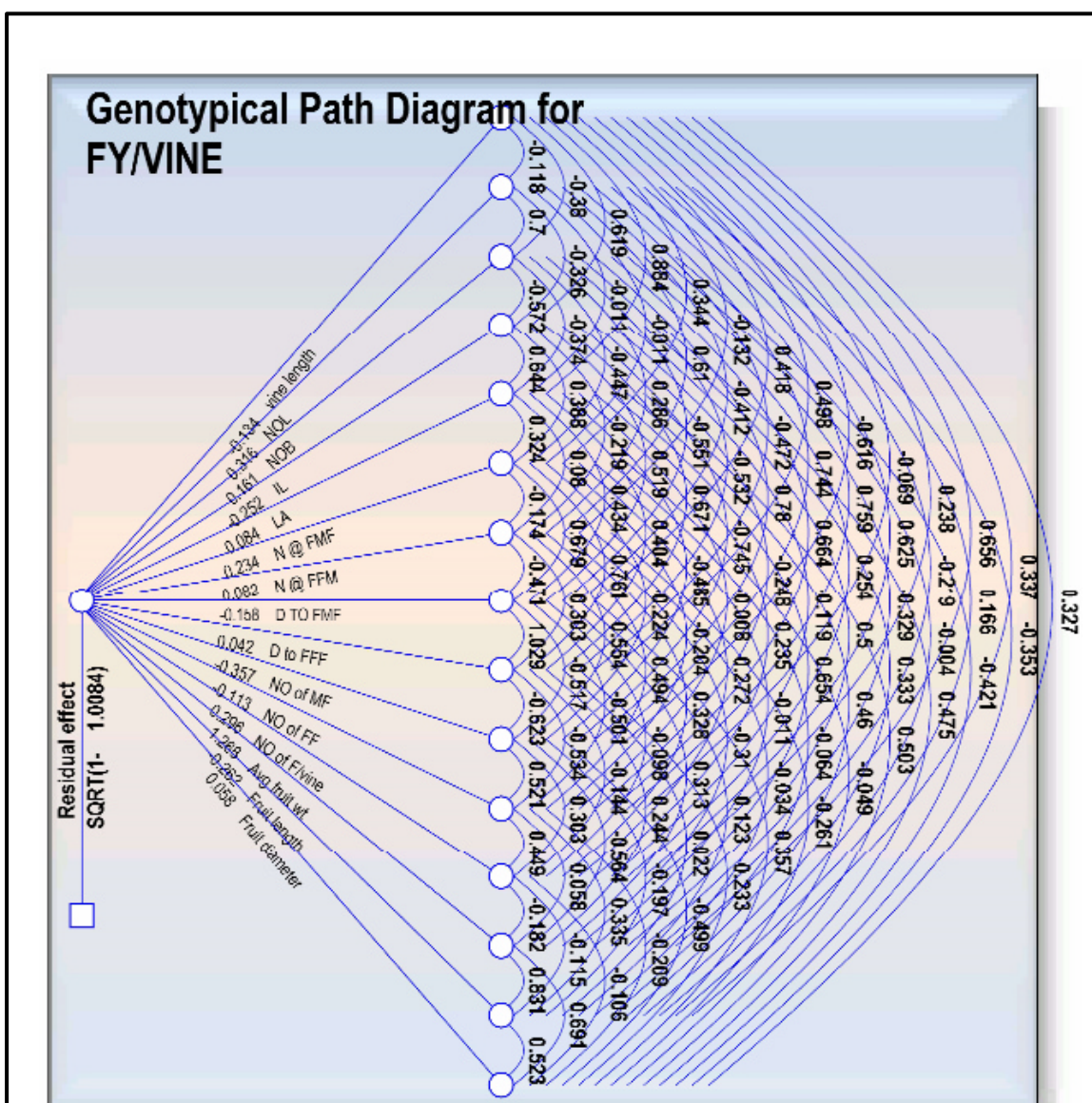


Fig. 7. Genotypic correlation coefficient among fruit yield per vine and its components in cucumber for *kharif* season

Characters

VL = Vine length (cm)

NOL = Number of leaves @ 90 DAS

IL = Internodal length (cm)

LA = Leaf area (cm²)

NOB = Number of branches per vine @ 75 DAS

DFMF = Days to first male flowering

DFFF = Days to first female flowering

NFMF = Node of first male flower appearance

NFFF = Node of first female flower appearance

NMF = Number of male flowers per vine

NFF = Number of female flowers per vine

NF/Y = Number of fruits per vine

AFW = Average fruit weight (g)

FL = Fruit length (cm)

CF = circumference of fruit (cm)

FY/V = Fruit yield per vine (kg).

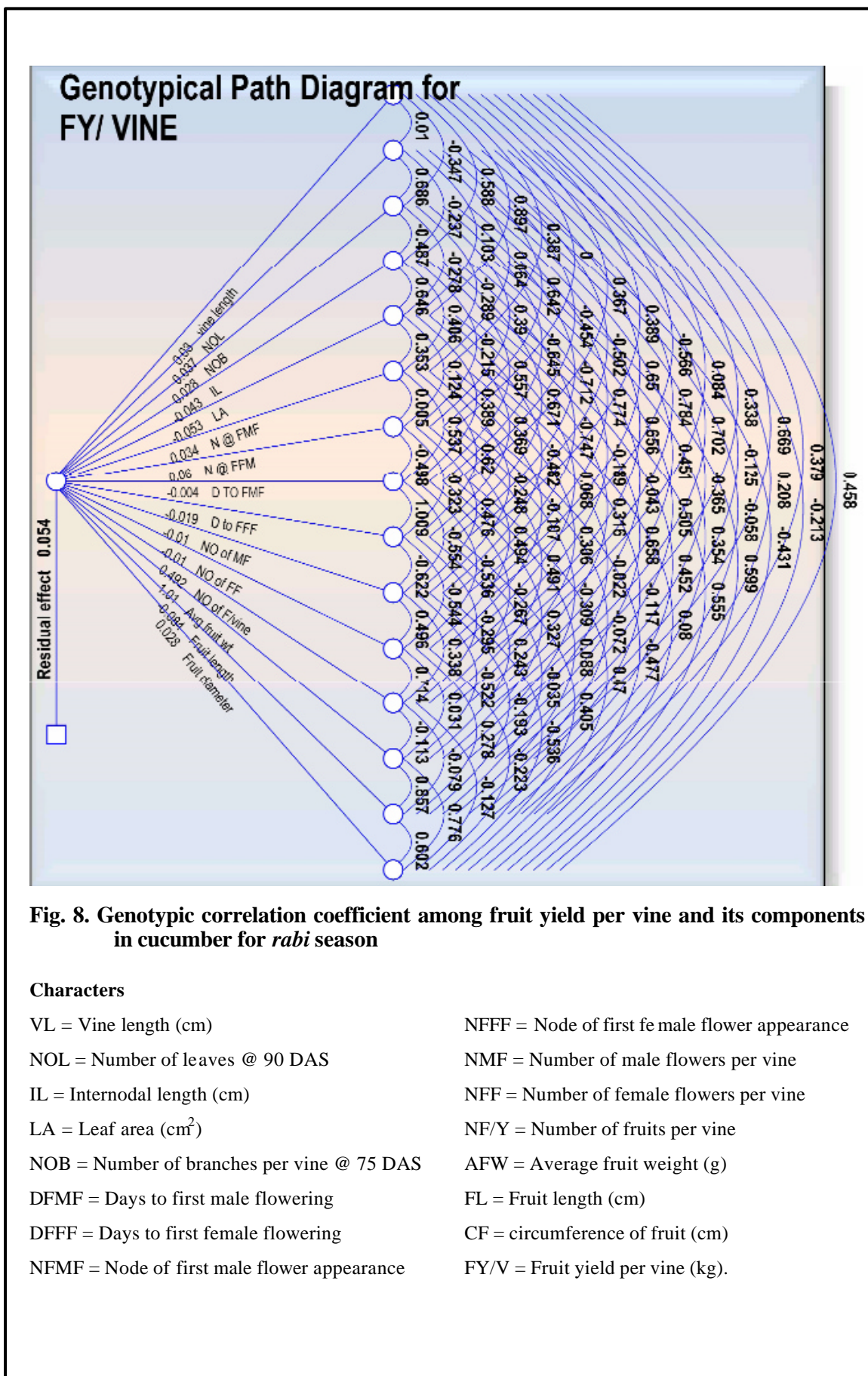


Fig. 8. Genotypic correlation coefficient among fruit yield per vine and its components in cucumber for *rabi* season

Characters

- VL = Vine length (cm)
- NOL = Number of leaves @ 90 DAS
- IL = Internodal length (cm)
- LA = Leaf area (cm²)
- NOB = Number of branches per vine @ 75 DAS
- DFMF = Days to first male flowering
- DFFF = Days to first female flowering
- NFMF = Node of first male flower appearance
- NFFF = Node of first fe male flower appearance
- NMF = Number of male flowers per vine
- NFF = Number of female flowers per vine
- NF/Y = Number of fruits per vine
- AFW = Average fruit weight (g)
- FL = Fruit length (cm)
- CF = circumference of fruit (cm)
- FY/V = Fruit yield per vine (kg).

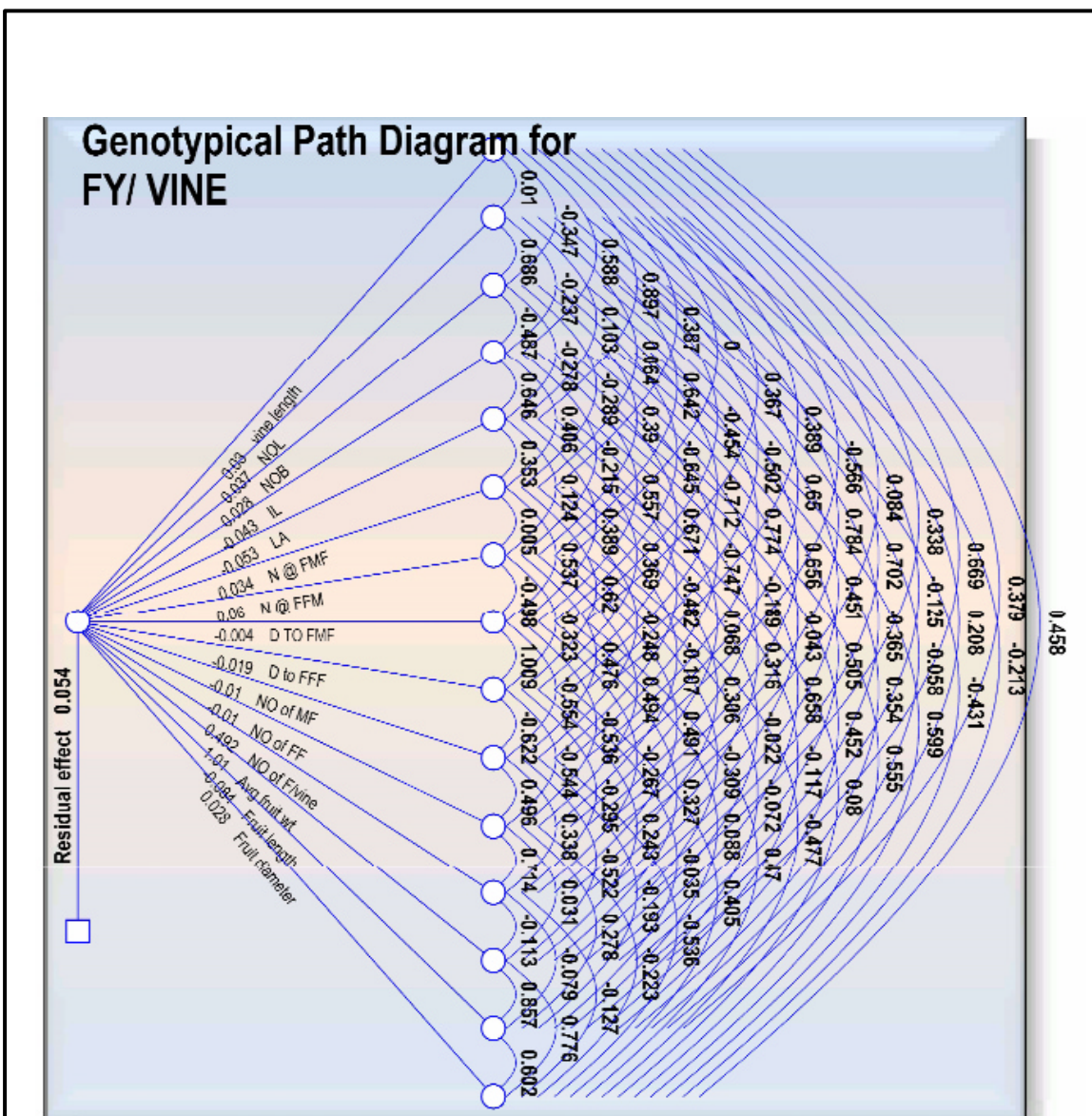


Fig. 9. Genotypic correlation coefficient among fruit yield per vine and its components in cucumber for pooled average over both the season

Characters

- VL = Vine length (cm)
- NOL = Number of leaves @ 90 DAS
- IL = Internodal length (cm)
- LA = Leaf area (cm²)
- NOB = Number of branches per vine @ 75 DAS
- DFMF = Days to first male flowering
- DFFF = Days to first female flowering
- NFMF = Node of first male flower appearance
- NFFF = Node of first female flower appearance
- NMF = Number of male flowers per vine
- NFF = Number of female flowers per vine
- NF/Y = Number of fruits per vine
- AFW = Average fruit weight (g)
- FL = Fruit length (cm)
- CF = circumference of fruit (cm)
- FY/V = Fruit yield per vine (kg).

In pooled average over both the seasons, path coefficient analysis at genotypic level revealed that average fruit weight had maximum positive direct effect on fruit yield per vine followed by node of first female flower appearance, number of fruits per vine, number of leaves per vine, node of first male flower appearance, vine length, circumference of fruit and number of branches per vine. At phenotypic level revealed that average fruit weight had maximum positive direct effect on fruit yield per vine followed by number of fruits per vine, days to first female flowering, node of first female flower appearance, circumference of fruit, number of female flowers per vine, number of leaves per vine, node of first male flower appearance and leaf area.

These findings are in line with Abusalekha and Datta (1990) for number of fruits per vine and average fruit weight; Hanchinamani and Patil (2008) for average fruit weight, total number of fruits per vine, days to first fruit harvest, node of first female flower appearance; Arunkumar *et al.* (2011) for average fruit weight, number of fruits per vine, number of branches per vine, vine length, days to first male flowering and days to first female flowering; Hasan *et al.* (2015) for number of fruits per vine, vine length, fruit length, fruit diameter and fruit weight; Khan *et al.* (2015A) for average fruit weight, number of fruits per vine, days to male flowering and fruit length in bitter gourd.

From the present path analysis study, it may be concluded that improvement in fruit yield per vine can be achieved by carrying selection for component characters which showed positive direct effect. While selecting high yielding types major emphasis should be given to traits like average fruit weight, number of fruits per vine, leaf area, node of first female flower appearance and number of leaves per vine with due consideration for node of first male flower appearance, vine length, fruit length, circumference of fruit and number of branches per vine.

5.5 Pest and disease incidence

The fruit fly is most serious pest of cucurbits defying chemical control in India. Likely some of major diseases seen in cucumber are powdery mildew, downy mildew and anthracnose. Hence any breeding programme for selection of best ideotype involving resistance to pest and disease must begin with extensive screening of genotypes.

The percentage of fruit fly infestation showed that none of the genotypes were free from attack. The genotypes HUB-13, HUB-1, Long Green and HUB-4 have low level of infestation and genotypes HUB-11 and HUB-9 showed highest fruit fly infestation. For powdery mildew the incidence was less in genotypes IIHR-303, HUB- 16 and IIHR-266. However, genotypes HUB-9, HUB-7 and HUB-14 have shown highest infestation. The genotypes HUB-2, HUB-1 and IIHR-285 have shown low level of downy mildew infestation. Genotypes HUB-7 and HUB-14 showed highest infestation and none of the genotype is free from attack. This might be due to grand growth stage coincidences with less temperature coupled with high relative humidity and genotypic performance resulted in occurrence of disease. Similar findings were opined by Harika *et al.* (2012) in bottle gourd, Shivaprasad *et al.* (2012) in muskmelon, Pal *et al.* (2016) in cucumber and Shruthi *et al.* (2016) in oriental pickling melon.

5.6 The varietal characterization of cucumber genotypes on DUS guidelines

Plant morphology has been in use for classification of plants since very long time for taxonomical classification of plants. Corollas Linnaeus used morphological characters. In plant genetic research Gregor John Mendel (1866) also used morphological traits for purity testing and identification of genotypes. In this method of genotype identification, plants have to be maintained till maturity.

The thirty genotypes were grouped individually into different categories for different parameters. Vine length is measured and recorded as short (6), intermediate (22) and long (2). Based upon plant growth habit genotypes are grouped as determinate, intermediate and indeterminate in which all genotypes were indeterminate. Leaf blade orientation as erect (10), horizontal (19) and drooping (1). Based upon leaf blade length as short (25), intermediate (5) and long (0). Stem pubescence was recorded as present (29) or absent (1). Stem shape as angular (10) or rounded (20). Appearance of first pistillate flower as early (8), medium (22) with no genotype under late. Plant sex expression as monoecious or gynoeceous, in which all genotypes were monoecious. Ovary colour of vestiture as white (23) or black (7). Parthenocarpy as present or absent and none of the genotype recorded parthenocarpy. Fruit length as short (17), medium (13) and long (0) based upon length of fruit at

edible maturity. Based upon fruit diameter as small, medium and large in which all were grouped under medium.

Genotypes were grouped under fruit shape as elongate (4), oblong (10), cylindrical (10) or oval (3). Fruit shape at peduncle end as flat (7), acute (14) and obtuse (9). Skin colour at marketable fruit maturity stage and categorized as creamy white (1), yellow (2), light green (13) and dark green (14). Presence (10) or absence (20) of ribs on fruits by visually observing. Presence (26) or absence (4) of lines or wrinkle on fruits by visual assessment. Based upon type of vestiture hair at edible maturity as hairy (17), non-hairy (6) or prickles (7). Density of vestiture hair on fruit as sparse (14), medium (4) or dense (6). Based upon seed size as small (23), medium (6) and large (1). Based upon Seediness as low (3), medium (16) and high (11) out of thirty genotypes. Similar studies were conducted by Choudhary *et al.* (2015) in muskmelon, Choudhary *et al.* (2016) in water melon and Sudhakara and Manchali (2016) in muskmelon.

Future line of work

1. Vine length, number of leaves at 90 DAS, leaf area, internodal length, number of branches per vine, number of fruits per vine, average fruit weight, fruit length and fruit yield per vine can be improved through direct selection from existing germplasm stock, as there is high degree of additive components of genetic variance with high GCV and PCV for these traits.
2. High heritability and genetic advance were observed for vine length, number of leaves at 90 DAS, leaf area, internodal length, number of branches per vine, node of first male flower appearance, number of male flowers per vine, number of female flowers per vine, sex ratio, fruit setting per cent, number of fruits per vine, average fruit weight, fruit length, fruit yield per vine, flesh thickness and vitamin- C content. Hence, attention has to be given to these traits during selection for crop improvement.
3. Yield can be improved by selecting genotypes for average fruit weight, number of fruits per vine, vine length, fruit length, number of leaves per vine, circumference of fruit, number of branches per vine, node of first male flower

appearance, node of first female flower appearance, leaf area and days to first male flowering as they had positive direct association with fruit yield per vine which is revealed from correlation and path analysis studies.

4. The lines identified for higher fruit yield viz. HUB-10, Long White, Long Green, IIHR-266, IIHR-303, HUB-1 these can be further assessed for their stability before exploiting them for commercial cultivation and could be used in hybridization programme.
5. Percentage infestation to fruit fly, downy mildew and powdery mildew was less in HUB-13, HUB-1, HUB-2, HUB-12, IIHR-303 and IIHR-285 with comparatively high number of marketable fruits per vine than other genotypes. Therefore, these genotypes can further be used in breeding programmes.
6. For recovering the improved progenies for yield and quality parameters crosses can be attempted between the clusters with maximum distances, respectively in all the season and also by considering the mean values in between the clusters for the particular trait in both the seasons for crop improvement of variety.

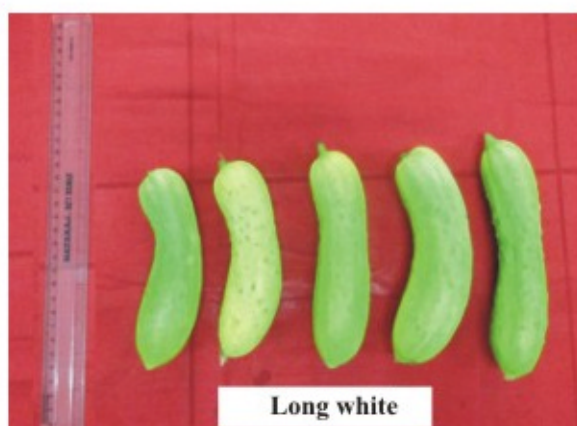
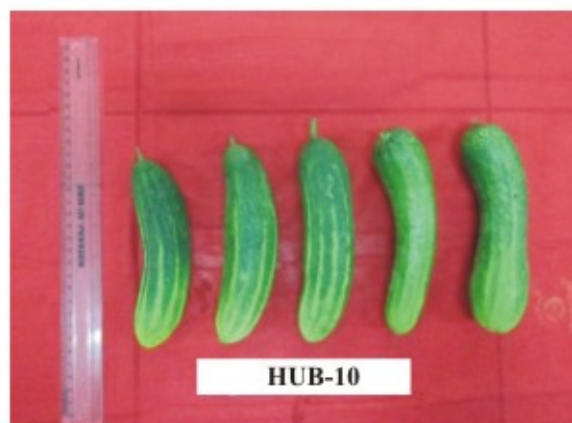


Plate 5: High yielding cucumber varieties identified

Table 35. Mean values for yield attributing traits of high yielding varieties

Parameters	HUB-1	HUB-10	Long White	Long Green	IIHR-266	IIHR-303
Sex ratio	6.27	5.28	5.44	5.38	6.22	5.42
Fruit setting per cent	47.73	47.18	51.60	49.05	45.19	52.33
Number of fruits per vine	7.73	5.60	5.43	5.70	6.85	8.47
Average fruit weight (g)	149.65	234.85	223.25	222.40	173.15	142.13
Fruit length (cm)	13.51	16.49	15.90	16.28	17.10	12.64
Circumference of fruit (cm)	12.80	15.65	14.90	14.70	14.08	11.99
Fruit yield per vine (kg)	1.16	1.32	1.22	1.23	1.19	1.18
Fruit yield per plot (kg)	11.64	13.16	12.21	12.32	11.86	11.78

6. SUMMARY AND CONCLUSIONS

The present investigation on “Morphological characterization of cucumber genotypes for improvement of local cultivar (*Cucumis sativus* L.)” was carried out in the field of Department of Vegetable Science, Kittur Rani Channamma College of Horticulture, Arabhavi, Belgaum districts of Karnataka during *kharif* and *rabi* seasons of 2017- 18. Experiment involving thirty genotypes were evaluated in randomized block design with two replications. Various growth, earliness, yield and quality parameters recorded were subjected to statistical analysis using INDOSTAT software to ascertain nature and magnitude of variability, correlation, path coefficient analysis and genetic divergence. The results obtained from the investigation have been summarized as below.

6.1 Variability studies

6.1.1 Coefficient of variation

The analysis of variance was significant ($p = 0.05$) for all the characters observed among the genotypes. For all the characters studied, phenotypic coefficient of variation was higher in magnitude than genotypic coefficient of variation, though difference was very less in major cases.

High ($> 20\%$) phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were observed for vine length, number of leaves at 90 DAS, leaf area, internodal length, number of branches per vine, number of fruits per vine, average fruit weight, fruit length, fruit yield per vine, fruit yield per plot and fruit yield per hectare in both *kharif*, *rabi* and also in pooled average over both the seasons.

Moderate (10-20%) phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were observed for node of first male flower appearance, number of male flowers per vine, number of female flowers per vine, sex ratio, fruit setting per cent, flesh thickness and vitamin-C content in both *kharif*, *rabi* and also in pooled average over both the seasons.

Low (< 10%) phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were observed for days to first male flowering, days to first female flowering, node of first female flower appearance, circumference of fruit, cavity thickness and total soluble solids in both *kharif*, *rabi* and also in pooled average over both the seasons.

6.1.2 Heritability and Genetic advance

High heritability (> 60%) and high genetic advance (> 20%) was observed for vine length, number of leaves at 90 DAS, leaf area, internodal length, number of branches per vine, number of fruits per vine, number of male flowers per vine, number of female flowers per vine, sex ratio, fruit setting per cent, number of fruits per vine, average fruit weight, fruit length, fruit yield per vine, fruit yield per plot, fruit yield per hectare, flesh thickness and vitamin- C content in *kharif*, *rabi* and also in pooled average over both the seasons.

High heritability (> 60%) coupled with moderate genetic advance (10-20%) was observed for days to first male flowering, node of first female flower appearance, circumference of fruit, cavity thickness and total soluble solids in *kharif* and pooled average over both the seasons. Node of first female flower appearance, circumference of fruit, cavity thickness and total soluble solids during *rabi*.

Moderate heritability (40-60%) coupled with low genetic (< 10%) advance was observed for days to first female flowering and days to first female flowering during *rabi*. Days to first female flowering alone during *kharif* and pooled average over both the seasons.

High heritability coupled with high genetic advance as per cent mean was obtained for all the characters indicating simple selection would be sufficient for these traits to bring genetic improvement.

6.2 Genetic divergence

Using Mahalanobis D^2 analysis method, 30 genotypes were grouped into eight, seven and ten divergent clusters in case of *kharif*, *rabi* and pooled average over both the seasons, respectively. In *kharif*, *rabi* and pooled average over both the

seasons maximum number of genotypes were in cluster I with 12 genotypes, cluster I with 15 genotypes, cluster I with 12 genotypes, respectively.

In *kharif* season, the intra cluster distance was found maximum in cluster V (387.92), maximum inter cluster distance was noted between cluster II and III (2532.09) and least inter cluster distance between cluster VI and VII (244.6). In *rabi* season, the intra cluster distance was found maximum in cluster V (375.58). Maximum inter cluster distance between cluster II and VI (4692.32) and least inter cluster distance between cluster IV and V (224.18). In pooled average over both the season, highest inter cluster distance was observed for cluster II (320.94). Maximum inter cluster distance between cluster III and VI (6818.97) and least inter cluster distance between cluster IV and VIII (459.33). This indicates genotypes belonging to these clusters are more diverse and hence, it is desirable to select these genotypes with high fruit yield per vine as parents in recombination breeding programme.

6.3 Correlation studies

In the present study genotypic and phenotypic correlation coefficients among different characters showed that fruit yield per vine is significantly positively correlated with average fruit weight, vine length, leaf area, fruit length, circumference of fruit, internodal length, number of fruits per vine and number of female flowers per vine in *kharif* season. In *rabi* season fruit yield per vine had significant positive correlation with average fruit weight, vine length, leaf area, fruit length, number of fruits per vine, circumference of fruit, number of female flowers per vine, number of leaves per vine and internodal length. While, fruit yield per vine showed significant positive correlation with average fruit weight, vine length, leaf area, fruit length, circumference of fruit, number of fruits per vine, number of female flowers per vine, internodal length and number of leaves per vine in case of pooled average over both the seasons.

Strong association of these traits revealed that selection based on these traits would ultimately improve the fruit yield and it is also suggested that hybridization of genotypes possessing combination of such characters is most useful for obtaining desirable high yielding segregants.

6.4 Path analysis

The characters like average fruit weight, number of fruits per vine, leaf area, node of first female flower appearance, number of branches per vine, number of leaves per vine and days to first female flowering had maximum positive direct effect on fruit yield per vine during *kharif* season. While in *rabi* season average fruit weight, number of fruits per vine, fruit length, vine length, days to first male flower and node of first female flower appearance showed positive direct effect on fruit yield per vine. In case of pooled average over both the seasons average fruit weight, number of fruits per vine, node of first female flower appearance, days to first female flowering and circumference of fruit had maximum positive direct effect on fruit yield per vine. This indicates scope for direct selection of these traits for improvement in cucumber.

The genotypes HUB-13, HUB-1, HUB-2, HUB-12, IIHR-303 and IIHR-285 had comparatively more number of marketable fruits per vine and lesser severity to fruit fly, downy mildew and powdery mildew than other genotypes, hence these genotypes can further be used in breeding programmes.

The lines identified for higher fruit yield *viz.* HUB-10, Long White, Long Green, IIHR-266, IIHR-303, HUB-1 these can be further assessed for their stability before exploiting them for commercial cultivation and could be used in hybridization programme.

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Appendix I**Meteorological data recorded during the period of experimentation (2017-2018)
at Agriculture Research Station, Arabhavi**

Month	Temperature (°C)			Relative humidity (%)	Rainfall (mm)	EVP (mm)
	Maximum	Minimum	Average			
January 2017	31.40	9.90	20.65	88.90	0.00	1.90
February 2017	33.80	11.30	22.55	89.60	0.00	4.00
March 2017	41.20	19.50	30.35	85.10	0.00	4.40
April 2017	38.80	20.10	29.45	85.50	0.00	7.40
May 2017	39.40	22.80	31.10	84.80	10.20	6.80
June 2017	32.40	22.60	27.50	86.00	15.00	5.00
July 2017	31.00	21.30	26.15	91.10	37.20	3.50
August 2017	32.90	20.50	26.70	88.90	40.40	3.90
September 2017	33.10	19.40	26.25	93.60	179.40	3.70
October 2017	33.30	19.10	26.20	88.70	91.20	5.00
November 2017	33.40	12.40	22.90	78.00	8.20	4.10
December 2017	33.70	10.50	22.10	78.00	3.20	3.80
January 2018	32.30	8.20	20.25	80.80	0.00	4.20

Appendix II

Per se performance of cucumber genotypes for growth, earliness, yield and quality parameters

Sl. No.	Variety	Vine length (cm)			Number of leaves at 90 DAS			Leaf area (cm ²)			Internodal length (cm)			Number of branches per vine		
		<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled
1	HUB-1	184.00	171.50	177.75	118.65	106.00	112.32	275.70	256.00	265.85	5.35	5.81	5.58	4.65	4.40	4.53
2	HUB-2	140.25	125.40	132.83	94.75	81.50	88.13	172.50	161.20	166.85	4.75	4.63	4.69	4.75	4.20	4.48
3	HUB-3	146.15	111.20	128.68	86.90	66.50	76.70	185.00	164.80	174.90	4.93	5.02	4.98	5.00	4.35	4.68
4	HUB-4	145.75	101.95	123.85	95.40	78.00	86.70	165.00	145.60	155.30	5.13	5.06	5.10	5.75	4.60	5.17
5	HUB-5	133.05	104.30	118.68	73.90	53.25	63.58	141.30	128.20	134.75	4.65	4.76	4.70	4.20	3.60	3.90
6	HUB-6	149.50	105.50	127.50	84.00	68.45	76.23	133.20	117.95	125.58	4.70	5.13	4.92	4.35	4.50	4.43
7	HUB-7	125.20	117.50	121.35	72.95	59.00	65.98	97.00	85.35	91.18	4.23	4.66	4.45	3.25	2.80	3.03
8	HUB-8	122.50	116.40	119.45	76.55	72.15	74.35	137.40	128.65	133.03	5.19	5.72	5.46	3.90	4.10	4.00
9	HUB-9	142.30	132.75	137.53	98.00	90.00	94.00	148.75	139.80	144.28	6.47	6.55	6.51	4.40	4.20	4.30
10	HUB-10	182.00	166.10	174.05	58.65	53.90	56.28	272.60	260.00	266.30	7.35	7.22	7.29	3.00	2.70	2.85
11	Long White	198.00	188.10	193.05	50.00	42.75	46.37	293.30	272.20	282.75	7.73	7.97	7.85	2.40	2.55	2.48
12	HUB-11	116.20	87.55	101.88	58.90	38.45	48.68	87.70	67.90	77.80	6.25	6.16	6.21	2.40	1.70	2.05
13	HUB-12	161.80	154.00	157.90	86.45	74.05	80.25	248.74	226.63	237.68	8.10	7.96	8.03	4.90	4.00	4.45
14	Long Green	219.00	170.50	194.75	58.50	47.60	53.05	337.78	314.39	326.09	9.71	9.67	9.69	3.15	3.00	3.08
15	HUB-13	137.50	114.65	126.08	99.85	82.35	91.10	157.50	139.90	148.70	6.02	6.33	6.18	4.60	3.50	4.05
16	HUB-14	115.95	102.75	109.35	61.25	43.00	52.13	79.50	60.30	69.90	6.29	5.97	6.13	3.80	2.65	3.23

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Sl. No.	Variety	Vine length (cm)			Number of leaves at 90 DAS			Leaf area (cm ²)			Internodal length (cm)			Number of branches per vine		
		<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled
17	HUB-15	123.50	101.50	112.50	82.35	64.25	73.30	136.50	122.75	129.63	6.23	7.1	6.67	4.20	3.70	3.95
18	HUB-16	215.00	194.10	204.55	65.00	54.00	59.50	322.45	308.50	315.48	11.70	10.85	11.28	1.95	1.80	1.87
19	HUB-17	136.80	104.00	120.40	82.60	63.95	73.28	106.25	91.95	99.10	5.25	5.54	5.39	3.65	3.75	3.70
20	HUB-18	142.50	113.00	127.75	92.35	76.05	84.20	131.00	117.50	124.25	5.99	6.18	6.09	4.65	3.75	4.20
21	HUB-19	133.55	107.50	120.53	84.00	72.95	78.48	145.00	128.50	136.75	4.65	5.02	4.83	4.60	3.90	4.25
22	Poona Khira	147.40	110.00	128.70	64.05	48.45	56.25	203.65	184.60	194.13	12.20	12.30	12.25	3.25	3.05	3.15
23	HUB-20	136.10	102.50	119.30	67.50	45.90	56.70	105.00	107.50	106.25	5.50	5.48	5.49	3.80	3.90	3.85
24	HUB-21	133.15	123.55	128.35	87.10	78.25	82.68	181.30	180.10	180.70	5.20	7.17	6.19	3.85	4.10	3.98
25	HUB-22	173.00	166.00	169.50	63.25	51.70	57.48	328.75	304.87	316.81	8.47	8.16	8.32	2.70	2.20	2.45
26	Poinsett	131.55	114.45	123.00	93.10	77.15	85.13	219.30	201.73	210.52	8.12	8.57	8.35	4.15	4.00	4.08
27	IIHR-264	133.70	119.90	126.80	64.90	46.05	55.48	152.18	141.36	146.77	7.77	7.22	7.50	3.70	4.00	3.85
28	IIHR-266	149.00	131.95	140.48	105.85	98.00	101.93	182.46	186.16	184.31	5.20	6.07	5.64	4.40	2.65	3.53
29	IIHR-285	155.90	137.35	146.63	110.05	109.20	109.63	319.80	309.80	314.80	7.40	7.77	7.59	3.20	4.30	3.75
30	IIHR-303	185.50	185.55	182.00	109.65	101.45	105.55	246.94	254.81	250.88	9.35	9.12	9.24	4.10	4.50	4.30
	Mean	150.52	129.23	139.83	81.54	68.14	74.03	190.45	176.96	183.70	6.66	6.83	6.75	3.89	3.54	3.71
	SE (d)	4.74	4.15	2.86	3.70	3.74	2.67	9.07	8.91	6.54	0.39	0.34	0.28	0.21	0.24	0.15
	CD _(0.05)	13.71	12.01	8.28	10.72	10.83	7.73	26.25	25.77	18.92	1.13	1.00	0.81	0.62	0.69	0.45
	CV (%)	4.45	4.54	2.89	6.47	7.77	5.05	6.74	7.12	5.03	8.34	7.15	5.91	7.85	9.58	5.96

Per se performance of cucumber genotypes for growth, earliness, yield and quality parameters

Sl. No.	Variety	Days to 1 st male flower			Days to 1 st female flower			Nodes up to 1 st male flower			Nodes up to 1 st female flower			Number of male flowers		
		<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled
1	HUB-1	30.40	36.45	33.42	37.50	42.75	40.13	2.50	3.00	2.75	5.05	5.15	5.10	111.00	92.00	101.50
2	HUB-2	32.35	38.20	35.28	39.15	43.80	41.48	2.65	2.50	2.58	5.60	4.95	5.28	109.00	103.50	106.25
3	HUB-3	32.15	40.40	36.28	38.10	46.15	42.13	2.55	2.65	2.60	5.45	5.25	5.35	115.50	97.60	106.55
4	HUB-4	31.20	37.95	34.58	40.70	43.60	42.15	2.30	2.55	2.43	4.60	4.90	4.75	100.35	84.00	92.18
5	HUB-5	31.90	38.80	35.35	38.50	45.00	41.75	2.45	2.70	2.58	4.75	4.70	4.73	97.10	83.00	90.05
6	HUB-6	29.70	40.45	35.08	36.60	45.35	40.98	2.40	2.63	2.52	4.70	5.05	4.88	91.60	81.30	86.45
7	HUB-7	31.00	38.90	34.95	37.35	47.20	42.28	2.85	2.75	2.80	4.65	4.30	4.48	99.85	80.00	89.93
8	HUB-8	31.40	40.25	35.83	38.85	46.70	42.78	2.10	2.50	2.30	5.25	4.35	4.80	97.30	78.00	87.65
9	HUB-9	36.20	40.05	38.13	41.40	47.20	44.30	2.70	2.85	2.78	4.75	4.80	4.78	105.00	88.50	96.75
10	HUB-10	40.90	43.85	42.38	43.80	49.25	46.53	3.10	3.00	3.05	4.15	4.00	4.08	67.00	60.00	63.50
11	Long White	41.20	42.80	42.00	43.00	48.40	45.70	3.10	3.25	3.18	3.90	3.85	3.87	63.50	52.50	58.00
12	HUB-11	36.83	42.05	39.44	42.60	46.65	44.63	2.83	2.75	2.79	4.95	4.30	4.63	86.00	72.80	79.40
13	HUB-12	40.10	40.00	40.05	44.00	47.05	45.53	2.90	2.84	2.87	5.10	4.65	4.88	94.80	75.00	84.90
14	Long Green	40.20	42.20	41.20	43.85	48.75	46.30	3.13	3.15	3.14	4.15	3.90	4.03	67.00	55.00	61.00
15	HUB-13	33.50	40.15	36.83	40.10	46.50	43.30	2.70	2.90	2.80	4.15	3.80	3.98	107.50	92.00	99.75
16	HUB-14	36.80	42.30	39.55	42.50	49.70	46.10	2.50	2.60	2.55	4.50	4.15	4.33	90.50	77.80	84.15

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Sl. No.	Variety	Days to 1 st male flower			Days to 1 st female flower			Nodes up to 1 st male flower			Nodes up to 1 st female flower			Number of male flowers		
		<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled
17	HUB-15	39.40	44.25	41.83	44.10	51.40	47.75	2.70	2.85	2.78	4.65	4.30	4.48	100.85	85.00	92.93
18	HUB-16	41.20	45.10	43.15	47.10	52.70	49.90	3.10	3.25	3.18	4.50	4.35	4.43	64.50	47.50	56.00
19	HUB-17	37.90	41.90	39.90	43.10	47.05	45.08	3.80	4.00	3.91	4.85	4.65	4.75	96.35	74.50	85.43
20	HUB-18	36.70	39.30	38.00	41.30	46.20	43.75	3.60	3.50	3.55	4.35	4.50	4.43	103.00	88.00	95.50
21	HUB-19	36.80	39.85	38.33	42.20	44.70	43.45	2.62	2.85	2.73	4.00	4.00	4.00	101.50	93.00	97.25
22	Poona Khira	32.60	40.65	36.63	40.55	48.20	44.38	2.80	3.13	2.96	4.40	4.15	4.28	62.50	47.00	54.75
23	HUB-20	36.50	41.25	38.88	42.35	50.10	46.23	3.70	3.45	3.58	4.20	4.15	4.18	99.25	88.50	93.88
24	HUB-21	37.00	41.95	39.48	40.15	47.25	43.70	2.60	2.85	2.73	4.70	4.20	4.45	104.75	91.50	98.13
25	HUB-22	37.90	41.10	39.50	44.60	50.70	47.65	3.40	3.35	3.38	5.30	5.15	5.23	82.10	66.00	74.05
26	Poinsett	35.25	42.35	38.80	39.65	47.00	43.33	2.95	3.10	3.03	4.90	4.65	4.78	103.00	89.00	96.00
27	IIHR-264	38.20	43.75	40.98	42.15	51.60	46.88	3.40	3.10	3.25	4.20	4.50	4.35	98.00	81.50	89.75
28	IIHR-266	37.30	41.35	39.33	43.60	48.10	45.85	3.15	3.23	3.19	5.20	5.05	5.13	100.00	90.50	95.25
29	IIHR-285	37.80	42.40	40.10	41.00	49.45	45.23	3.74	3.40	3.57	5.05	4.95	5.00	102.00	82.50	92.25
30	IIHR-303	35.40	39.50	37.45	41.80	47.15	44.48	3.60	4.15	3.88	5.25	5.45	5.35	94.00	77.50	85.75
	Mean	35.85	40.98	38.42	41.38	47.52	44.27	2.93	3.02	2.97	4.70	4.53	4.62	93.82	79.16	86.49
	SE (d)	0.87	1.39	0.86	1.24	1.03	0.88	0.21	0.224	0.17	0.23	0.20	0.16	2.90	2.72	2.00
	CD _(0.05)	2.52	4.03	2.49	3.60	2.99	2.55	0.62	0.64	0.49	0.68	0.59	0.48	8.39	7.88	5.79
	CV (%)	3.44	4.80	3.17	4.26	3.08	2.81	10.37	10.46	8.09	7.08	6.38	5.13	4.37	4.86	3.27

Appendix II

Per se performance of cucumber genotypes for growth, earliness, yield and quality parameters

Sl. No.	Variety	Number of female flowers			Sex ratio (male: female)			Fruit setting percentage			Number of fruits per vine			Average fruit weight (g)		
		<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled
1	HUB-1	16.50	16.00	16.25	6.74	5.81	6.27	41.53	53.94	47.73	6.85	8.60	7.73	142.95	156.35	149.65
2	HUB-2	15.50	13.50	14.50	7.04	7.69	7.37	34.75	51.19	42.97	5.40	6.85	6.13	141.90	149.25	145.58
3	HUB-3	16.85	12.60	14.73	6.87	7.75	7.31	30.57	49.85	40.21	5.15	6.30	5.75	143.60	137.50	140.55
4	HUB-4	14.90	11.70	13.30	6.74	7.26	7.00	31.87	46.76	39.31	4.75	5.45	5.10	154.15	149.25	151.70
5	HUB-5	17.05	12.20	14.63	5.70	6.80	6.25	35.51	47.94	41.73	6.05	5.85	6.25	142.60	133.00	137.80
6	HUB-6	14.40	11.35	12.88	6.38	7.20	6.79	34.00	51.11	42.55	4.90	5.75	5.33	150.05	138.95	144.50
7	HUB-7	13.70	10.50	12.10	7.30	7.65	7.47	38.35	58.55	48.45	5.25	6.15	5.70	124.35	117.80	121.08
8	HUB-8	15.00	10.70	12.85	6.49	7.31	6.90	37.19	47.81	42.50	5.55	5.10	5.33	135.85	129.23	132.54
9	HUB-9	16.70	15.10	15.90	6.29	5.87	6.08	32.89	44.95	38.92	5.50	6.80	6.15	175.85	187.39	181.62
10	HUB-10	12.90	11.20	12.05	5.19	5.36	5.28	38.94	55.42	47.18	5.00	6.20	5.60	236.80	232.90	234.85
11	Long White	11.60	9.90	10.75	5.53	5.35	5.44	49.73	53.48	51.60	5.60	5.25	5.43	215.60	230.90	223.25
12	HUB-11	10.25	7.65	8.95	8.40	9.51	8.96	38.05	33.92	35.99	3.90	2.60	3.25	139.30	145.95	142.63
13	HUB-12	14.60	11.30	12.95	7.47	6.65	6.58	40.24	46.78	43.51	5.10	5.25	5.18	167.70	170.50	169.10
14	Long Green	12.05	10.60	11.33	5.57	5.19	5.38	45.75	52.35	49.05	5.50	5.55	5.70	219.40	225.40	222.40
15	HUB-13	13.20	11.90	12.55	8.16	7.74	7.95	43.41	46.48	44.94	5.75	5.50	5.88	181.95	176.90	179.43
16	HUB-14	11.50	8.30	9.90	7.90	9.40	8.65	31.86	33.07	32.46	3.65	2.75	3.20	143.90	151.50	147.70

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Sl. No.	Variety	Number of female flowers			Sex ratio (male: female)			Fruit setting percentage			Number of fruits per vine			Average fruit weight (g)		
		<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled
17	HUB-15	12.00	11.00	11.50	8.42	7.74	8.08	51.71	56.00	53.86	6.20	6.15	6.18	52.85	53.41	53.13
18	HUB-16	12.50	11.80	12.15	5.16	4.03	4.59	36.99	43.20	40.09	4.60	5.10	4.85	215.90	238.35	227.13
19	HUB-17	12.10	11.80	11.95	7.97	6.32	7.15	52.98	51.65	52.32	6.40	6.10	6.25	56.30	54.37	55.33
20	HUB-18	16.60	12.70	14.65	6.23	6.93	6.58	30.10	44.45	37.28	5.00	5.65	5.45	151.45	165.00	158.23
21	HUB-19	14.75	14.05	14.40	6.88	6.64	6.76	32.53	40.56	36.54	4.80	5.70	5.25	139.00	140.45	139.73
22	Poona Khira	13.70	11.00	12.35	4.57	4.28	4.43	34.73	47.83	41.28	4.75	5.20	4.98	167.20	172.00	169.60
23	HUB-20	10.95	8.75	9.85	9.08	10.13	9.60	52.32	55.36	53.84	5.70	4.85	5.28	114.80	110.30	112.55
24	HUB-21	12.10	9.90	11.00	8.66	9.33	9.00	43.40	62.04	52.72	5.25	6.10	5.93	154.35	163.45	158.90
25	HUB-22	10.50	8.50	9.50	7.84	7.93	7.88	51.14	65.03	58.09	5.35	5.50	5.43	158.80	155.55	157.18
26	Poinsett	17.40	12.50	14.95	5.94	7.17	6.56	29.62	47.21	38.42	5.15	6.90	6.53	174.95	167.40	171.18
27	IIHR-264	13.20	10.55	11.88	7.46	7.78	7.62	34.93	54.66	44.80	4.60	5.70	5.15	142.80	159.65	151.23
28	IIHR-266	17.90	13.20	15.55	5.60	6.85	6.22	38.03	52.34	45.19	6.80	6.90	6.85	166.35	179.95	173.15
29	IIHR-285	14.60	10.45	12.53	7.02	7.94	7.48	40.01	53.33	46.67	5.85	5.55	5.70	170.80	181.05	175.93
30	IIHR-303	16.50	15.20	15.85	5.70	5.13	5.42	44.23	60.44	52.33	7.30	9.15	8.47	145.40	138.85	142.13
	Mean	14.05	11.53	12.79	6.80	7.02	6.91	39.52	50.25	44.75	5.38	5.81	5.66	154.23	157.08	155.65
	SE (d)	0.66	0.75	0.49	0.34	0.52	0.32	2.63	3.61	2.29	0.32	0.34	0.21	6.30	7.10	5.36
	CD _(0.05)	1.91	2.26	1.43	1.007	1.51	0.92	7.61	10.45	6.06	0.92	1.00	0.62	18.22	20.54	15.52
	CV (%)	6.65	9.20	5.49	7.23	10.51	6.54	9.48	10.16	6.62	7.54	8.14	5.35	5.77	6.39	4.87

Per se performance of cucumber genotypes for growth, earliness, yield and quality parameters

Sl. No.	Variety	Fruit length (cm)			Circumference of fruit (cm)			Yield per vine (kg)			Yield per plot (kg)			Yield per hectare (q)		
		<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled
1	HUB-1	13.02	14.00	13.51	12.45	13.15	12.80	0.98	1.35	1.16	9.81	13.46	11.64	90.85	124.66	107.75
2	HUB-2	13.00	13.80	13.40	12.50	13.00	12.75	0.77	1.02	0.89	7.70	10.18	8.94	71.32	94.29	82.81
3	HUB-3	12.88	13.50	13.19	13.05	12.70	12.88	0.74	0.87	0.81	7.39	8.71	8.05	68.43	80.66	74.54
4	HUB-4	13.77	13.94	13.86	12.25	13.05	12.65	0.73	0.81	0.77	7.31	8.13	7.72	67.65	75.24	71.45
5	HUB-5	13.60	12.06	12.83	12.70	11.25	11.98	0.86	0.78	0.82	8.62	7.78	8.20	79.82	72.08	75.95
6	HUB-6	14.45	13.65	14.05	12.85	12.45	12.65	0.73	0.80	0.77	7.33	8.01	7.67	67.85	74.15	71.00
7	HUB-7	9.70	8.20	8.95	13.70	13.40	13.55	0.65	0.72	0.69	6.53	7.23	6.88	60.43	66.91	63.67
8	HUB-8	12.40	11.69	12.05	13.60	13.30	13.45	0.75	0.66	0.71	7.54	6.60	7.07	69.81	61.07	65.44
9	HUB-9	17.20	19.70	18.45	13.20	13.90	13.55	0.97	1.27	1.12	9.70	12.66	11.18	89.86	117.21	103.54
10	HUB-10	17.00	15.98	16.49	15.55	15.75	15.65	1.19	1.45	1.32	11.85	14.46	13.16	109.76	133.94	121.85
11	Long White	15.30	16.50	15.90	14.70	15.10	14.90	1.22	1.22	1.22	12.26	12.15	12.21	113.52	112.54	113.03
12	HUB-11	12.65	13.20	12.93	11.80	12.35	12.08	0.54	0.38	0.46	5.44	3.78	4.61	50.34	35.04	42.69
13	HUB-12	16.85	15.50	16.18	14.10	13.60	13.85	0.86	0.89	0.87	8.55	8.94	8.74	79.17	82.76	80.97
14	Long Green	15.80	16.75	16.28	14.50	14.90	14.70	1.21	1.25	1.23	12.12	12.52	12.32	112.18	115.96	114.07
15	HUB-13	17.65	16.91	17.28	14.55	14.25	14.40	1.05	0.97	1.01	10.49	9.70	10.09	97.13	89.79	93.46
16	HUB-14	15.10	14.09	14.59	12.95	13.20	13.08	0.53	0.42	0.47	5.26	4.16	4.71	48.75	38.51	43.63

Contd....

Sl. No.	Variety	Fruit length (cm)			Circumference of fruit (cm)			Yield per vine (kg)			Yield per plot (kg)			Yield per hectare (q)		
		<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled
17	HUB-15	4.90	4.56	4.73	12.20	11.65	11.92	0.33	0.33	0.33	3.28	3.28	3.28	30.39	30.37	30.38
18	HUB-16	16.16	17.00	16.58	14.70	15.05	14.88	0.99	1.21	1.10	9.91	12.11	11.01	91.76	112.15	101.95
19	HUB-17	5.62	5.82	5.72	11.95	12.25	12.10	0.36	0.33	0.35	3.60	3.31	3.46	33.36	30.63	31.99
20	HUB-18	17.00	16.75	16.88	12.65	13.70	13.18	0.76	0.93	0.84	7.58	9.31	8.45	70.23	86.18	78.21
21	HUB-19	14.38	13.85	14.12	12.05	12.90	12.48	0.67	0.80	0.73	6.67	8.02	7.34	61.72	74.30	68.01
22	Poona Khira	16.05	16.85	16.45	15.20	15.70	15.45	0.80	0.89	0.84	7.95	8.94	8.44	73.66	82.74	78.20
23	HUB-20	8.49	8.00	8.24	13.70	13.30	13.50	0.65	0.53	0.59	6.53	5.34	5.93	60.44	49.41	54.92
24	HUB-21	16.20	14.85	15.53	15.45	14.20	14.83	0.81	1.00	0.90	8.10	9.98	9.04	75.02	92.37	83.69
25	HUB-22	13.64	12.07	12.86	14.00	13.15	13.58	0.85	0.86	0.86	8.51	8.61	8.56	78.76	79.74	79.25
26	Poinsett	17.00	15.28	16.14	15.25	14.50	14.88	0.90	1.16	1.03	9.02	11.56	10.29	83.51	107.07	95.29
27	IIHR-264	11.16	11.39	11.27	12.90	13.95	13.43	0.66	0.91	0.78	6.56	9.10	7.83	60.76	84.22	72.49
28	IIHR-266	16.95	17.25	17.10	13.70	14.45	14.08	1.13	1.24	1.19	11.30	12.42	11.86	104.67	115.02	109.85
29	IIHR-285	18.75	16.40	17.58	13.90	14.50	14.20	1.00	1.00	1.00	9.98	10.03	10.00	92.40	92.87	92.64
30	IIHR-303	13.78	11.50	12.64	11.33	12.65	11.99	1.06	1.30	1.18	10.60	12.95	11.78	98.15	119.93	109.04
	Mean	14.15	13.70	13.85	13.44	13.57	13.51	0.82	0.91	0.86	8.24	9.11	8.68	76.38	84.40	80.39
	SE (d)	0.63	0.70	0.48	0.46	0.55	0.33	0.069	0.067	0.05	0.68	0.67	0.52	6.36	6.23	4.85
	CD _(0.05)	1.82	2.03	1.41	1.35	1.61	0.96	0.20	0.19	0.15	1.98	1.94	1.51	18.39	18.01	14.03
	CV (%)	6.36	7.27	4.99	4.92	5.80	3.48	11.85	10.46	8.54	11.76	10.43	8.52	11.76	10.43	8.53

Appendix II

er se performance of cucumber genotypes for growth, earliness, yield and quality parameters

Sl. No.	Variety	Flesh thickness (mm)			Cavity thickness (mm)			Vitamin C content (mg/100g)			TSS (^o brix)			Fruit color	Hairiness	Number of locules
		<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled			
1	HUB-1	13.12	14.91	14.02	23.30	23.44	23.37	3.15	3.33	3.24	2.55	2.76	2.66	Dark green	Hairy	3
2	HUB-2	14.20	16.65	15.43	22.35	21.35	21.85	2.28	2.72	2.50	2.70	3.00	2.85	Light green	Hairy	3
3	HUB-3	18.64	18.93	18.78	22.87	21.71	22.29	2.55	2.85	2.70	3.15	3.33	3.24	Dark green	Hairy	3
4	HUB-4	16.29	15.13	15.71	22.62	22.91	22.76	3.49	3.76	3.62	2.35	2.50	2.43	Light green	Hairy	3
5	HUB-5	13.78	14.60	14.19	24.03	24.01	24.02	2.65	3.13	2.89	2.94	3.39	3.17	Dark green	Hairy	3
6	HUB-6	13.54	12.14	12.84	23.97	24.15	24.06	3.15	3.57	3.36	2.38	2.65	2.51	Light green	Hairy	3
7	HUB-7	12.99	13.01	13.00	26.63	26.36	26.49	2.75	3.17	2.96	2.50	2.65	2.58	Light green	Hairy	3
8	HUB-8	13.58	14.58	14.08	23.93	24.10	24.01	3.15	3.45	3.30	2.45	2.69	2.57	Dark green	Hairy	3
9	HUB-9	15.59	15.11	15.35	24.42	23.66	24.04	3.40	4.28	3.84	2.68	2.83	2.75	Light green	Hairy	3
10	HUB-10	18.90	17.27	18.09	24.00	23.13	23.57	2.55	2.46	2.51	2.65	2.89	2.77	Dark green	Prickles	3
11	Long White	15.24	18.81	17.02	26.52	27.24	26.88	3.15	3.76	3.46	2.35	2.50	2.43	Creamy white	Prickles	3
12	HUB-11	13.69	15.16	14.42	23.62	23.83	23.72	2.60	3.08	2.84	2.30	2.45	2.38	Dark green	Non-hairy	3
13	HUB-12	13.37	15.09	14.23	24.18	23.60	23.89	2.85	3.62	3.23	2.35	2.60	2.48	Light green	Non-hairy	3
14	Long Green	17.25	20.30	18.78	22.85	24.10	23.48	3.40	4.45	3.93	2.44	2.61	2.52	Light green	Prickles	3
15	HUB-13	14.70	15.03	14.58	23.75	22.25	22.73	2.45	2.75	2.60	2.74	3.37	3.05	Dark green	Non-hairy	3
16	HUB-14	13.03	14.46	14.03	22.82	21.71	22.54	3.10	3.41	3.26	2.55	2.70	2.63	Light green	Hairy	3

Contd.....

Sl. No.	Variety	Flesh thickness (mm)			Cavity thickness (mm)			Vitamin C content (mg/100g)			TSS (^o brix)			Fruit color	Hairiness	Number of locules
		<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled	<i>Kharif</i>	<i>Rabi</i>	Pooled			
17	HUB-15	7.65	9.19	8.42	24.70	24.67	24.68	2.35	2.58	2.47	2.52	2.67	2.60	Yellow	Non-hairy	3
18	HUB-16	19.93	18.56	19.25	18.27	16.68	17.48	3.50	4.49	4.00	2.27	2.42	2.35	Light green	Prickles	3
19	HUB-17	8.49	8.74	8.61	25.52	24.45	24.98	2.25	2.14	2.20	2.56	2.81	2.68	Yellow	Non-hairy	3
20	HUB-18	12.30	12.95	12.63	20.95	20.95	20.95	3.80	4.20	4.00	2.55	2.70	2.63	Dark green	Hairy	3
21	HUB-19	12.50	13.51	13.01	23.45	23.51	23.48	2.80	3.37	3.09	2.78	3.16	2.97	Dark green	Non-hairy	3
22	Poona Khira	14.87	16.74	15.80	23.53	23.07	23.30	2.90	3.62	3.26	2.60	2.75	2.68	Dark green	Prickles	3
23	HUB-20	13.58	13.12	13.35	24.34	24.91	24.62	2.65	3.47	3.06	2.15	2.48	2.32	Light green	Hairy	3
24	HUB-21	12.09	13.02	12.56	24.81	23.61	24.21	3.00	3.62	3.31	2.68	2.98	2.83	Dark green	Hairy	3
25	HUB-22	14.30	17.95	16.12	23.03	23.00	23.02	3.35	4.05	3.70	2.50	2.65	2.58	Light green	Prickles	3
26	Poinsett	15.33	14.40	14.87	23.57	24.22	23.89	2.73	2.93	2.83	2.74	2.89	2.81	Dark green	Hairy	3
27	IIHR-264	12.32	12.40	12.36	23.70	24.87	24.29	2.67	3.10	2.88	2.40	2.60	2.50	Light green	Prickles	3
28	IIHR-266	14.38	13.64	14.01	25.95	26.69	26.32	2.10	2.46	2.28	2.48	2.58	2.53	Dark green	Hairy	3
29	IIHR-285	13.68	14.21	13.75	25.87	25.52	25.70	2.85	3.91	3.38	2.68	2.83	2.75	Dark green	Hairy	3
30	IIHR-303	12.48	13.67	13.07	23.58	20.70	22.14	3.10	3.60	3.35	2.85	3.10	2.98	Light green	Hairy	3
	Mean	13.85	14.77	14.41	23.76	23.47	23.62	2.89	3.37	3.13	2.56	2.78	2.66			
	SE (d)	0.68	0.71	0.50	0.63	0.98	0.58	0.15	0.23	0.13	0.076	0.107	0.08			
	CD _(0.05)	1.99	2.05	1.44	1.83	2.85	1.70	0.45	0.68	0.39	0.220	0.31	0.23			
	CV (%)	6.92	7.27	4.90	3.78	5.95	3.55	7.76	9.92	6.19	4.21	5.46	4.26			

Appendix III

Morphological DUS descriptors of cucumber

Morphological character	State	Morphological character	State
A- Plant growth habit	1-Determinate 2-Intermediate 3-Indeterminate	K- Fruit diameter	3-Small (<3cm) 5- Medium (3-5 cm) 7- Large (>5)
B- Plant main vine length	1-Short (<1.25m) 2-Intermediate (1.25-2.0m) 3-Long (>2.0m)	L- Fruit shape	1-Elongate 2-Oblong 3-Cylindrical 4-Oval
C- Leaf blade orientation	1-Erect 2-Horizontal 3-Drooping	M- Fruit shape at peduncle end	1-Flat 2-Acute 3-Obtuse
D- Leaf blade length	3-Short (14 cm) 5-Medium (14-20cm) 7-Long (>20cm)	N- Fruit colour of skin at market stage	1-Creamy white 2-Yellow 3-Light green 4-Dark green
E- Stem pubescence	1-Absent 9-Present	O- Fruit ribs	1-Absent 9-Present
F- Stem shape	1-Angular 2-Rounded	P- Fruit creasing	1-Absent 9-Present
G- Appearance of first pistillate flower in 50% plant	3-Early < 40 days 5-Medium 40-55 days 7-Late >55 days	Q- Fruit type of vestiture hair	3-Hairy 5-Non-hairy 7-Prickles
H- Plant sex expression	1-Monoecious 9-Gynoecious	R- Fruit density of vestiture	3-Sparse 5-Medium 7-Dense
I- Ovary colour of vestiture	1-White 2-Black	S- Seed size	3-Small (<1.00cm) 5-Medium (1.00-1.20cm) 7-Large (75-100)
J- Fruit length	3-Short (<15) 5- Medium (15-25cm) 7- Long (>25cm)	T- Seediness	3-Low (75-100) 5-Medium (100-150) 7-Medium (>150)

**MORPHOLOGICAL CHARACTERIZATION OF CUCUMBER GENOTYPES
FOR IMPROVEMENT OF LOCAL CULTIVAR (*Cucumis sativus* L.)**

DEEPA S. K.

2018

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ABSTRACT

Cucumber (*Cucumis sativus* L.) is one of the most important cucurbitaceous vegetable crop grown extensively in tropical and sub-tropical parts of the country. The investigation was carried out in the field of Department of Vegetable Science, Kittur Rani Channamma College of Horticulture, Arabhavi, Gokak (Karnataka) during *kharif* and *rabi* seasons of 2017-18. Experiment involving thirty genotypes collected from various sources was evaluated in RCBD design with two replications.

The analysis of variance revealed highly significant difference among the genotypes for all the characters studied indicating the higher magnitude of variability in the germplasm in *kharif*, *rabi* and also in pooled average of both the seasons.

The estimates of PCV were higher than the GCV for all the characters studied, indicating that variation is not only due to genetic but also influenced by environmental factors. High heritability coupled with high genetic advance was observed for vine length, leaf area, intermodal length, number of fruits vine⁻¹, number of male and female flowers vine⁻¹, sex ratio, fruit setting per cent, number of fruits vine⁻¹, average fruit weight, fruit length, fruit yield vine⁻¹, fruit yield plot⁻¹, fruit yield hectare⁻¹, flesh thickness and vitamin- C content at both the seasons, Which reveals that variation in these characters is mainly due to the action of additive genes and these traits can be improved by direct selection.

Correlation and path analysis studies revealed that fruit yield vine⁻¹ had significant positive association with average fruit weight, vine length, leaf area, fruit length, circumference of fruit, number of fruits vine⁻¹ and number of female flowers vine⁻¹. Maximum positive direct effect on fruit yield vine⁻¹ was exhibited through average fruit weight, number of fruits vine⁻¹ and leaf area. Hence direct selection for these traits would be more useful in the improvement of yield.

Using Mahalanobi's D² analysis, 30 genotypes were grouped into 8, 7 and 10 clusters during *kharif*, *rabi* and pooled average over both seasons respectively. The intra cluster distance was found maximum in cluster-V in *kharif* and *rabi* and cluster-II in pooled average of seasons. The lines identified for higher fruit yield viz. HUB-10, Long White, Long Green, IIHR-266, IIHR-303 and HUB-1 were identified on the basis of their *per se* performance can be used for further evaluation and also as base material for hybridization programme.

