STUDIES ON GENETIC VARIABILITY IN CUCUMBER (*Cucumis sativus* L.)

By

Miss. Anita Govind Gaikwad

(Reg. No. 05/094)

A Thesis submitted to the
MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI - 413 722, DIST.AHMEDNAGAR,
MAHARASHTRA, INDIA

in partial fulfilment of the requirements for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

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2007

CANDIDATE'S DECLARATION

I hereby declare that this thesis or part there of has not been submitted by me or other person to any other University or Institute for a Degree or Diploma

A Gaikwad

Place : M.P.K.V., Rahuri (Anita Gaikwad)

Dated : 15 / 6 /2007

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Maharashtra State (India)

CERTIFICATE

This is to certify that the thesis entitled, **'STUDIES ON GENETIC VARIABILITY IN CUCUMBER (*Cucumis sativus* L.)'**, submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra state, India, in partial fulfilment of the requirement for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **HORTICULTURE**, embodies the results of a piece of *bona fide* research work carried out by **MISS. ANITA GOVIND GAIKWAD** under my guidance and supervision and that no part of the thesis has been submitted for any other University for degree, diploma or publication in other form.

The assistance and help received during the course of this investigation and sources of literature referred to have been duly acknowledged.

Place : M.P.K.V., Rahuri

Dated : 15/ 6 /2007.

(A.M. Musmade)
Research Guide

Dr. A.S. Jadhav
Associate Dean,
Post Graduate Institute,
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Rahuri - 413 722, Dist. Ahmednagar,
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Place : M.P.K.V.,Rahuri

Dated : 15 / 6 /2007.

(A.S. Jadhav)

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A Gaikwad

Place : M.P.K.V., Rahuri (Anita G. Gaikwad)

Date : 15/6/2007

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LIST OF ABBREVIATIONS

%	:	Per cent
B.d.	:	Broad sense
C.D.	:	Critical difference
cm	:	Centimeter
et al.	:	Et alli (And others)
etc.	:	Et cetera
Fig.	:	Figure
g	:	Gram
GA	:	Genetic advance
GCV	:	Genotypic coefficient in variation
ha	:	Hectare
i.e.	:	That is
kg	:	Kilogram
m	:	Meter
MSS	:	Mean sum of squares
MT	:	Metric tonnes
PCV	:	Phenotypic coefficient of variation
PDI	:	Per cent disease intensity
S.E.	:	Standard error
T.S.S.	:	Total soluble solids
viz.,	:	Videlicet (namely)

ABSTRACT

"STUDIES ON GENETIC VARIABILITY IN CUCUMBER (*Cucumis sativus* L.)

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MASTER OF SCIENCE (AGRICULTURE)

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2007

Research Guide	:	Dr. A.M. Musmade
Department	:	Horticulture

Eighteen cucumber genotypes obtained from different geographic regions were evaluated to study the nature and extent of genetic divergence and correlation among different characters.

A high degree of variation was observed with respect to all the characters studied. The estimates of genotypic coefficient of variation were low as compared to estimates of phenotypic coefficient of variation. The high genotypic as well as phenotypic coefficient of variation was observed for characters such as PDI followed by length of fruit, number of fruits per vine, weight of fruit and node number of first female flower.

The highest heritability (broad sense) percentage was observed for all the characters. Comparatively high heritability (Broad sense) percentage was observed for days to first harvest, length of fruit weight of fruit, PDI, days to appearance of first female flower, final vine length and core diameter. While the characters final vine length and weight of fruit recorded high percentage of heritability along with higher estimates of genetic advance indicating additive gene effects in their inheritance and scope for selection. High heritability coupled with medium or low genetic advance was exhibited by days to first harvest, PDI, days to appearance of first female flower, length of fruit, days to appearance of first male flower, node number of first female flower, number of fruits per vine, diameter of fruit, core diameter, yield per vine, thickness of flesh is attributable to the non-additive gene effects. This indicates that hybridization, followed by selection, will be effective for genetic improvement.

The estimates of genotypic correlation, in general, were slightly higher than the estimates of phenotypic correlation, indicating minimum effect of environment on the expression of characters.

The yield per vine exhibited significant but negative correlation with PDI at both genotypic and phenotypic levels. It showed non-significant but positive correlation with final vine length at both genotypic and phenotypic levels. The weight of

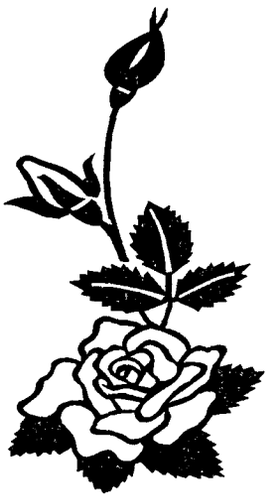
fruit showed significant and positive correlation with diameter of fruit, thickness of flesh and core diameter at both genotypic and phenotypic levels. The number of fruits per vine showed significant and positive correlation with yield per vine at both genotypic and phenotypic levels.

D^2 analysis showed a wide genetic divergence among the genotypes of cucumber with D^2 values ranging from 294.93 to 15976.42. Eighteen genotypes were grouped into eight cluster divergence and cluster mean. A tentative breeding programme has been suggested for improving the various economic characters of cucumber. The genotypes Himangi, Phule Shubhangi, Panvel, Improved long green, J-02, KOP-2, Poona Khira and Poinsette hold promise as potential parents in developing improved cucumber hybrids.

Pages 1 to 88



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INTRODUCTION





1. INTRODUCTION

Cucumber (*Cucumis sativus* L.) is one of the Asiatic species and a member of the cucurbitaceae family. It is a typical vegetable of warm temperate and tropical areas. Cucumber is the second most important vegetable species next to tomato in Western Europe, where it is cultivated mainly in glass house (Grubben, 1977). It is also one of the most popular salad crops in the USA, Eastern Europe and Middle East. However, in the subtropics and tropics, the cucumber is less important, but is more popular in Asia, Particularly in the cooler areas. Grubben (1977) felt that export of slicing and pickling cucumbers to temperate areas could become economically important for some regions.

Cucumber is one of the earliest maturing vine crops and is grown in almost all parts of India. It is grown during both summer as well as rainy seasons. Cucumber is rich in minerals such as P, Na, Ca, Mg, Fe, S and K and vitamins B and C. The calorific and nutritional value of cucumber is very low. However, it is a popular vegetable in developed countries where there is an excessive calorie intake (Grubben, 1977).

The cucumber is thought to be indigenous to India, since tremendous variations were found for fruit size, shape, skin colour and vegetative characters in India and adjacent countries (Whitaker and Bemis, 1979). However, it has hardly been studied systematically and very little work has been reported from India.

Cucumber possesses good medicinal properties, since it has cooling effects and prevents constipation, jaundice and allied diseases. It is also used in cosmetic preparations. Cucumber seeds possess diuretic, purgative and antipyretic properties (Nayar and More, 1998) and are used in Ayurvedic preparations.

In India, the area under cucumber is about 18,000 ha with production 120,000 MT. However, Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh, Gujarat etc., are the major cucumber producing states. In Maharashtra, it is cultivated over 4,935 ha area with production 88,830 MT (Anonymous, 2003). In Maharashtra cucumber is predominantly grown in Konkan region and western Maharashtra.

The consumer preferences for cucumber vary from regions to region. In some parts of Maharashtra, mainly Poona Khira types are preferred but in other parts again the consumer preferences are different. In Kolhapur district long type light green, spineless fruits are preferred, while in Pune district white coloured, thorny fruits are preferred. In Uttar Pradesh the long and green Balam Khira types and in the hills of North Bengal, Darjeeling and Sikkim type fruits are preferred.

In USA, pickling cucumber of small size are preferred while in Western Europe the long, slender, parthenocarpic, slicing cucumber with thick skin and dark green colour are preferred. In Middle East, the cucumber of 12-18 cm length with very thick skin is preferred.

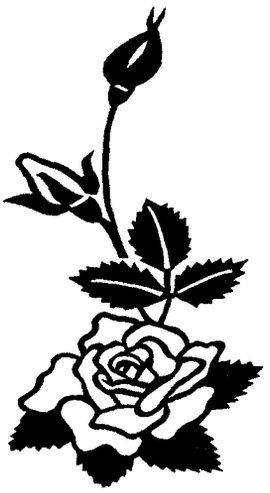
The study of variability is an important pre requisite in any breeding programme for improvement of the crop as well as exploitation of heterosis. Being a cross-pollinated crop, it shows a large amount of genetic variation. Selection of high yielding varieties with desired quality attributes is very essential for successful breeding programme, where the efficiency of selection depends mainly on the nature and extent of variability in a population i.e. genetic variability is the soul of plant breeding which is important for improvement of quantitative characters.

The basic idea in the study of variation is its partitioning into components attributed to yield. Further, the association between different pairs of characters is helpful in understanding various attributes of yield and related components. Thus, the correlation coefficient indicates the degree of relationship between characters.

A wide range of variability and large number of distinct forms distributed all over the country provides maximum opportunity for genetic improvement not only for high yield but also for better quality, consumer acceptability and disease resistance. An attempt has been made in the present investigation to study the variability and correlation among different characters in different genotypes of cucumber in summer season with the following objectives.

1. To study the nature and extent of genetic variability.
2. To measure the nature and magnitude of genetic divergence between the different genetic stocks.

3. To group different cultivars on the basis of their relative genetic distance.
4. To study the heritability and genetic advance.
5. To estimate the genotypic and phenotypic correlation and coefficient in cucumber.



REVIEW OF LITERATURE





2. REVIEW OF LITERATURE

Cucumber is one of the most important and popular vegetable crops grown on commercial scale in India and abroad also. Many earlier workers have worked on different aspects of this crop. The relevant literature related to evaluation of varieties for different characters, genetic variability and association of characters is reviewed under different suitable headings.

2.1 Concept of divergence

The concept of D^2 statistics for measuring the divergence between populations was introduced by Mahalanobis (1936). It gives results based on the magnitude of divergence and is independent of the size of sample.

The utility of D^2 analysis in discriminating populations belonging to diverse genetic and geographic origins has been discussed by several workers (Arunachalam and Ram, 1967 and Kalloo *et al.*, 1980).

2.2 Genetic diversity in cucumber

A successful breeding programme is associated with diversity of the parents within a reasonable range. More the diversity, better are the chances of improving the economic characters under consideration in the resulting offsprings. It also helps to know the relative distance between these strains for the characters under study.

Rao *et al.* (2003) studied thirty one genotypes to assess genetic divergence by using Mahalanobis' D^2 statistic. The genotypes were grouped into 16 clusters based on

similarities of D^2 values. Genotypes from different regions were distributed into various clusters at random, demonstrating that the geographical isolation may not be one of the factor for causing biological or genetic diversity.

2.2.1 Literature concerned with other cucurbitaceous crops

Singh and Lal (2000) studied fifty one genotypes of musk melon to assess genetic divergence using D^2 statistic. The genotypes were grouped in to 13 clusters. The intra cluster distance was maximum in cluster VIII and minimum in clusters IX, X, XI, XII and XIII. The inter cluster distance was maximum between cluster VII and XII and minimum between cluster I and II. Maximum divergence was provided by the node at which first female flower opened and minimum by fruit yield per vine.

Badade *et al.* (2001b) studied genetic diversity among twenty diverse cultivars of bottle gourd for seven quantitative characters. The cultivars differed significantly for almost all the characters and were grouped into 10 clusters based on the similarities of D^2 value. Considerable diversity within and between clusters was noted and it was observed for the characters of vine length, number of branches, percentage of female flowers, fruits per vine, length and diameter of fruit and yield per vine.

Mukunda *et al.* (2003) studied thirteen quantitative characters in twenty one diverse pumpkin genotypes using Mahalanobis' D^2 statistic. The genotypes were grouped in 10 clusters. The maximum genetic distance was observed between

clusters III and VI. The characters, namely number of days to first female flower, vine length, number of first female flowering node, fruit weight, number of seeds per fruit, number of fruits per vine and thousand seed weight contributed maximum divergence.

Narayankutty *et al.* (2004) studied genetic diversity among 36 genotypes of snake gourd. They were grouped into six clusters. Observed the range of variation for flesh thickness, fruits per pit and node at which first male and female flowers were formed were low among the multi member clusters. The characters *viz.,* days to first male and female flower opening, fruit girth, days to first harvest and 100 seed weight exhibited moderate variation. High range of variation was observed for fruit yield, average fruit weight, seeds per fruit and fruit length.

Cluster V had the earliest flowering genotypes in the present study. The three genotypes *viz.,* JJK 105, SBD-93 and TA-54 included in this cluster recorded early maturity, lowest average fruit weight, yield per plant, flesh thickness and hundred seed weight. On the contrary the genotypes of cluster III were late maturing with the highest fruit weight and yield per plant, thus contributing to higher inter cluster distance between cluster III and cluster V.

2.3 Variability studies in cucumber

Solanki and Seth (1980) observed phenotypic variability among 24 varieties of cucumber. A considerable amount of phenotypic variability was observed in most of the characters such as plant height, leaf number per plant, number

of male flowers per plant, number of female flowers per plant and days to maturity, while the variability was considerably low for the other characters.

Joshi *et al.* (1981) observed wide range of phenotypic variation for eight characters in twenty genotypes of cucumber, except for the number of primary branches. Phenotypic and genotypic coefficients of variations did not show much differences for different characters except for vine length, number of primary branches and flesh : seed ratio. Phenotypic performance was observed to be a good index for selection in cucumber for the characters like node number with first fruit, fruit length, fruit circumference, number of fruits per plant and fruit yield per plant.

Naga Prasuna and Rama Rao (1988) reported wide range of variation for fourteen characters except for number of primary branches per vine in F_2 progenies of cucumber. Number of fruits per vine and yield per vine exhibited high degree of phenotypic and genotypic variation.

Abusaleha and Dutta (1990 a) recorded high genotypic and phenotypic coefficient of variation for vine length, branches per vine, fruits per vine, fruit length, fruit girth and flesh thickness in seventy five genotypes.

Mariappan and Pappiah (1990) observed wide range of variation for fourteen characters in fourty five diverse genotypes of cucumber except number of leaves per plant. The phenotypic coefficient of variation was high for weight of seeds per fruit and average fruit weight.

Rastogi and Arya Deep (1990) studied genetic variability in 25 genotypes of cucumber including indigenous as well as exotic types. Considerable amount of phenotypic variation was observed for vine length, number of male flowers, fruit maturity period, fruit weight, fruit yield per plant.

Prasad and Singh (1994) reported that, the PCV was higher than GCV for all the characters studied, in cucumber, but in a few cases these two values differed slightly. The differences between PCV and GCV were small for the characters like days to appearance of male and female flower, fruit breadth, placental thickness.

Saikia *et al.* (1995) reported high GCV and PCV for yield per plant, fruit weight, number of fruits per plant, number of leaves per plant and node to first female flower. The phenotypic coefficient of variation was minimum for days to first picking in cucumber.

Ram *et al.* (2001) observed wide range of variation for twelve characters in eleven genotypes of cucumber. The estimates of PCV and GCV were high for yield, number of fruits per plant and fruit length.

Tawade (2002) observed higher estimates of genotypic and phenotypic coefficients of variation in twenty five genotypes for the characters i.e. volume of fruit, seed weight per fruit, weight of fruit, fruit yield per vine and number of fruits per vine.

2.3.1 Literature concerned with other cucurbitaceous crops

Indiresh (1982) reported high PCV and GCV for yield per plant, average fruit weight and volume of fruit in 24 genotypes in bitter gourd.

Swamy *et al.* (1985) reported high PCV and GCV for yield per plant, average fruit weight and vine length, while days to first harvest showed lowest estimates of PCV in 45 genotypes of musk melon.

Lawande (1987) reported high estimates of variability for fruit yield per vine, fruit weight, fruit length, fruit diameter and number of fruits per vine in eleven cultivars of bitter gourd.

Sahni *et al.* (1987) recorded considerable variability for all the characters in ridge gourd. The highest genotypic and phenotypic coefficient of variation was observed for fruits per vine.

Lalta Prasad *et al.* (1988) reported high phenotypic and genotypic coefficient of variation for number of fruits per vine, average fruit weight, seeds per fruit, hundred seed weight and fruit yield per vine in germplasm of watermelon.

Prasad and Singh (1990) reported high phenotypic and genotypic coefficient of variation for fruit length, yield per plant and vine length. The number of fruits and fruit width showed moderately high estimates of PCV and GCV in ridge gourd.

Verghese and Rajan (1993) observed high phenotypic coefficient of variation for fruits per vine, fruit length, yield per

plant, while days to male flower, days to first harvest, flesh thickness and days to female flower recorded low estimates of PCV in snake gourd.

Rajput *et al.* (1996) reported high PCV and GCV for seeds per fruit and yield per vine in bitter gourd.

Somkuwar *et al.* (1997) recorded highest phenotypic coefficient of variation in musk melon for PDI. The other characters *viz.*, average fruit weight, number of fruits per plant and yield per plant recorded high phenotypic and genotypic coefficient of variation whereas, low genotypic and phenotypic coefficient of variation was recorded for days to first harvest.

Mathew and Khader (1999) reported high PCV and GCV for average fruit weight, seeds per fruit, fruit yield per plant and fruit length in 34 genotypes of snake gourd.

Shanthi Priya (2001) in evaluation of watermelon observed higher PCV and GCV for 100 seed weight, weight of fruit and yield per vine.

Chowdhury and Sarma (2002) reported higher GCV than PCV for vine length, number of fruits per plant, fruit length, fruit girth and fruit weight in 12 genotypes of ridge gourd.

Dora *et al.* (2002) reported high GCV for node at which first female flower appeared followed by number of nodes per plant, weight of fruit, number of fruits per plant and number of branches per plant in pointed gourd.

Jeeva and Pappiah (2002) reported high GCV for first male and female flower node, weight of fruit, length of fruit and yield per plant in snapmelon indicating the presence of high

degree of variability and better scope for improvement of these characters through selection.

Narshimha Rao *et al.* (2002) recorded high PCV with equally high GCV in yield per vine, fruits per vine, fruits per branch and node of first male flower, indicating maximum variability in the genotypes for these characters in ridge gourd.

Singh *et al.* (2002) observed high PCV and GCV for node number for appearance of first male flower, male flowers per plant, sex ratio on whole plant, main axis and branches, fruits per plant, fruit weight, seeds per fruit and yield per plant. The GCV and PCV values were almost equal for most of the characters studied in ridge gourd.

Torkadi (2003) reported that, the PCV was higher than GCV for all characters studied, in muskmelon. The highest phenotypic as well as genotypic coefficients of variation was observed for economically important characters such as average weight of fruit, fruit cavity and number of fruits per vine.

Gurukaran Singh and Tarsem Lal (2005) reported that, the estimates of the PCV were higher than those of GCV indicating presence of environmental influence.

2.4 Heritability and genetic advance

Phenotype of an individual is determined by genotype and environment in which it grows. Success of a breeder in Improving the characteristics of populations, therefore depends upon the degree of correspondence between phenotypic value and genotypic value. Heritability is a measure that provides this information (Dabholkar, 1992). The most important function of

heritability in the genetic studies of metric characteristics is it's predictive role in expressing the reliability of the phenotypic value as a guide to breeding value (Falconer, 1981).

A brief summary of work done in cucumber for estimating heritability and genetic advance of yield and quality characteristics is presented here.

Solanki and Seth (1980 b) observed phenotypic variability, high heritability and high expected genetic advance for plant height, days to maturity and fruit yield among 24 varieties of cucumber. Further, high heritability and low expected genetic advance were recorded for average fruit weight, duration of flowering, primary branches per plant and fruits per plant.

Naga Prasuna and Rama Rao (1988) reported high heritability for number of female flowers per vine, percentage of fruit set, number of fruits per vine, fruit volume and average fruit weight, while number of primary branches per vine, days to first female flower appearance and node at which first female flower appeared reported medium heritability estimates. Very high percentage of mean genetic advance for traits like average fruit weight, number of fruits per vine and fruit volume, while days to female flower showed low genetic advance as percentage of mean. High heritability coupled with high genetic advance was recorded for all the traits except days to female flower and number of primary branches per vine.

Abusaleha and Dutta (1990 a) reported high genetic advance with high heritability in cucumber for node at which

female flower appeared. Fruits per vine and fruit length showed moderate genetic advance with high value of heritability.

Mariappan and Pappiah (1990) observed high heritability and high genetic advance in cucumber for fruit girth, days to staminate flower, weight of seed per fruit, indicating the action of additive genes for expression of these characters.

Rastogi and Arya (1990) studied 25 genotypes of cucumber and observed that large portion of phenotypic heritability with high genetic advance for fruit yield per plant, fruit weight, number of female flowers and number of fruits per plant, suggests the additive gene effect.

Prasad and Singh (1994) reported high heritability and high genetic advance for vine length, days to male and female flower, fruit weight, fruit length in 23 genotypes of cucumber indicating the role of additive gene effect in expression of these characters.

Saikia *et al.* (1995) reported maximum heritability in cucumber for main vine length, yield per plant and flesh thickness. High heritability with high GCV and PCV was recorded for yield per plant, fruit weight, number of fruits per plant, number of leaves per plant and node to first female flower. Maximum genetic advance was recorded for yield per plant followed by node to first female flower and number of leaves per plant. High heritability with low genetic advance was observed for number of male flowers per plant, days to anthesis of first male and female flower, number of female flowers per plant, fruit length, fruit girth and days to first picking.

Ram *et al.* (2001) observed high heritability for fruit length and average fruit weight and high genetic advance for yield per plant and average fruit weight in eleven genotypes of cucumber.

Tawade (2002) reported high estimates of broad sense heritability and genetic advance over mean for weight of fruit, volume of fruit, fruit yield per vine and seed weight per fruit, indicating additive gene actions in the expression of these characters and suggested that straight selection would be effective for improvement of above characters in breeding programme.

2.4.1 Literature concerned with other cucurbitaceous crops

Indiresh (1982) reported high heritability with high genetic advance for characters like leaf area, fruit weight, fruit length and volume of fruit while low value of genetic advance and heritability for days to female flower, days to first harvest in bitter gourd.

Swamy *et al.* (1985) in musk melon reported high heritability along with high genetic advance as percentage of mean for average weight of fruit, flesh thickness and yield per vine. The yield per plant, average fruit weight and 100 seed weigh recorded high estimates of heritability.

Sahni *et al.* (1987) in ridge gourd recorded higher amount of heritability for fruits per vine, fruit weight and branches per vine. The estimates of genetic advance over mean

were high and low for fruits per vine and fruit length, respectively.

Abusaleha and Dutta (1990 b) observed high estimates of heritability coupled with high genetic advance as percent of mean for fruits per vine, fruit length, vine length and yield per vine in 45 genotypes of sponge gourd.

Prasad and Singh (1990) reported high heritability accompanied with high genetic advance for yield per plant, fruit length, fruit width and moderate for vine length and number of fruits per vine in ridge gourd.

Verghese and Rajan (1993) reported high heritability and high genetic gain for fruits per plant, seed weight per fruit and average fruit weight. The yield per vine, fruit length, days to first harvest and days to first male flower exhibited high heritability with low genetic gain, indicating the scope for development of F_1 hybrids for yield per plant and earliness in snake gourd.

Rajput *et al.* (1996) reported high heritability along with high genetic advance over mean for seeds per fruit, fruit length, branches per vine and yield per vine indicating additive gene effect for these characters in bitter gourd.

Somkuwar *et al.* (1997) reported high heritability and medium genetic advance for F : C ratio, PDI, yield per plant, number of fruits per plant and fruit weight in muskmelon.

Mathew and Khader (1999) observed high heritability along with high genetic advance for average fruit weight, seeds per fruit, fruit length, days to male flower and fruit yield per

plant, indicating the presence of additive gene action in snake gourd.

Chowdhury and Sarma (2002) reported high values of heritability and genetic advance for vine length, yield per hectare, fruit weight, indicating that these traits were characterized by additive gene effect in ridge gourd.

Dora *et al.* (2002) reported high heritability with low genetic advance for diameter of fruit, days taken for the appearance of first female flower, fruit length, weight of fruit, inter nodal length, fruit set percentage, fruit retention percentage and days taken from fruit set to marketable maturity due to non-additive type of gene action in pointed gourd.

Jeeva and Pappiah (2002) reported high heritability with high genetic advance for first male flower node, number of fruits per plant and yield per plant indicating additive gene action while high heritability and moderately high genetic advance for first female flower node, weight of fruit and length of fruit. Low heritability and very low genetic advance were recorded for days to first male flower appearance and girth of fruit indicating non-additive gene action in snapmelon.

Narshimha Rao *et al.* (2002) reported that high heritability coupled with high genetic advance as per cent mean was observed for yield per vine followed by fruits per vine, fruits per branch and node of first male flower in both the seasons indicating the presence of additive gene action and consequently a distinct possibility of improving these characters by simple selection in ridge gourd.

Singh *et al.* (2002) reported high values of broad sense heritability for all the characters in ridge gourd. High heritability with high genetic advance was observed for number of nodes for appearance of first male and female flower, length of main axis, number of primary branches, male and female flowers per plant, sex ratio on the whole plant, main axis and branches, fruits per plant, fruit set, fruit length, fruit weight, seeds per fruit, 100-seed weight and yield per plant.

Torkadi (2003) in muskmelon observed high estimates of heritability in broad sense for number of fruits per vine, weight of fruits per vine, average fruit weight, fruit length, fruit diameter, pulp thickness, fruit cavity and PDI. High heritability values with high genetic advance were obtained for the characters average weight of fruit and fruit cavity. This suggested the presence of additive gene effects offering a good scope for improvement of these characters by selection.

Gurukaran Singh and Tarsem Lal (2005) reported highest estimates of heritability and genetic advance for node at which 1st female flower opens and rind thickness in muskmelon.

2.5 Correlation studies

Solanki and Seth (1980) reported higher magnitude of genotypic correlation coefficient over respective phenotypic and environmental correlation coefficient in 24 genotypes of cucumber.

Haribabu (1985) observed strong simple correlation coefficient of yield with fruit weight (0.618). While the yield had positive association with number of fruits (0.183), thus

indicating that the mean fruit weight was responsible for increase in yield in ten F_1's of cucumber. Vine length showed significant association with number of branches and non-significant association with yield per vine. Number of branches per vine had significant association with number of fruits per vine.

Choudhary and Mandal (1987) reported that yield per vine had positive correlation with number of fruits per vine, fruit length and fruit weight in 30 genotypes of cucumber. The number of secondary branches per vine, length of vine and diameter of fruit did not show significant correlation with yield.

Abusaleha and Datta (1988) reported that yield per vine was positively correlated with vine length, branches per vine, fruits per vine, fruit length, fruit girth and flesh thickness. The days to opening of female flower and male flower were negatively correlated with the yield per vine in 75 genotypes of cucumber.

Naga Prasuna and Rama Rao (1989) observed that the days to female flower, number of fruits per vine, average fruit weight and number of primary branches per vine had positive association with yield per vine at phenotypic and genotypic level. Number of fruits per vine showed strong negative association with average fruit weight in F_2 progenies of cucumber.

Rajput *et al.* (1991) reported the significant positive correlation between number of fruits and yield per vine in cucumber.

Pandian and Irulappan (1993) reported significant and positive association of fruit weight, fruit length, fruit girth, flesh thickness and number of fruits per vine with yield, while fruit weight had significant and positive association with fruit length, fruit girth and flesh thickness. The fruit weight had negative association with number of fruit per vine. Fruit length showed significant and positive association with fruit girth and flesh thickness. The fruit girth showed positive and significant association with flesh thickness in 51 genotypes of cucumber.

Chen *et al.* (1994) reported that the fruit yield per vine had significant positive genotypic correlation with number of fruits per vine and average fruit weight in parthenocarpic cucumber cultivars.

Prasad and Singh (1994) reported that the vine length had significant positive association with fruit weight (0.47) and flesh thickness (0.79). Fruit yield was positively and significantly correlated with fruit weight (0.64), flesh thickness (0.32) and negatively correlated with days to first flowering (0.42). The fruit weight was positively correlated with fruit breadth (0.51) and flesh thickness (0.70) in cucumber.

Ma *et al.* (1995) observed that the yield per vine had a significant positive correlation with number of fruits per vine and average fruit weight. Vine length had positive effect on total yield in 16 hybrids and 8 parents in cucumber.

Neikov and Alexandrova (1995) reported that fruit yield was significantly correlated with number of fruits per vine and fruit weight in 115 salad varieties of cucumber.

Saikia *et al.* (1995) observed that the yield per vine had strong positive association with vine length, number of branches, number of fruits per vine, fruit weight and fruit length at genotypic and phenotypic level in cucumber.

Dhaliwal and Randhawa (1998) observed higher magnitude of genotypic correlation coefficient over the corresponding phenotypic coefficient in 62 genotypes of cucumber. The yield per vine had significant and positive association with fruit weight (0.273), fruit diameter (0.231) and seeds per fruit (0.251). The days to first female flower had significant positive association with days to first harvest.

Tawade (2002) observed that fruit yield per vine had highly significant and positive association with number of fruits per vine at genotypic and phenotypic levels and had positive and appreciable association with weight, length, volume and girth of fruit, seed weight per fruit, length of vine and rind thickness of fruit at genotypic and phenotypic levels. The fruit yield per vine had negative and appreciable association with days to staminate flower and days to first harvest. The days to staminate flower, pistillate flower and first harvest had significant and positive association with each other. The fruit weight, length, girth, rind thickness, volume of fruit and seed weight per fruit had positive and significant correlation among each other.

Rao *et al.* (2004) reported that yield was positively correlated with fruit weight, fruit length and flesh thickness at both genotypic and phenotypic levels in 31 genotypes of cucumber. The highest positive genotypic correlation was found

between fruit weight and length while days to first female flower, node number of first female flower and days to first harvest had a non-significant negative correlation with yield per plant.

2.5.1 Literature concerned with other cucurbitaceous crops

Singh *et al.* (1977) reported higher genotypic correlation coefficient over the corresponding phenotypic correlation coefficient, indicating a strong inherent association among the characters in bitter gourd. The fruit yield had significant positive correlation with number of fruits per vine and fruit length at phenotypic and genotypic level. The fruit length was significantly and positively associated with number of fruits per plant.

Mangal *et al.* (1978) observed that the fruit yield had significant and positive correlation with number of fruits and average fruit weight in bitter gourd. The fruit yield had negative correlation with days to flowering and number of branches per vine. The number of fruits was negatively correlated with days to first female flower. The fruit length was significantly and positively correlated with fruit weight and seeds per fruit.

Abusaleha and Dutta (1990 c) observed significant and positive correlation of yield per vine with fruit length, number of fruits per vine, branches per vine and vine length in 65 genotypes of ridge gourd.

Somkuwar *et al.* (1997) in correlation studies in muskmelon reported highly significant correlation between total yield per plant and number of fruits per plant, average fruit weight and F : C ratio in favourable direction. Favourable and significant

associations were also recorded between average fruit weight and F : C ratio and days to first harvest and average fruit weight.

Sarkar *et al.* (1999) reported higher magnitude of genotypic correlation coefficient over phenotypic ones in most of the traits. Yield per plant had positive and significant correlation with number of primary branches per vine, fruit volume and fruit weight at genotypic and phenotypic levels. The yield per vine was significantly and positively correlated with vine length and seeds per fruit at genotypic level in 16 strains of pointed gourd.

Badade *et al.* (2001) reported the yield was significantly and positively correlated with number of branches per vine, percentage of female flowers and number of fruits per vine in bottle gourd, while significantly and negatively correlated with days to first male and female flower appearance and weight of deformed fruits per vine at both phenotypic and genotypic levels. At genotypic level, vine length, diameter of fruit, core diameter, number of seeds per fruit, and 100 seed weight showed significant and negative correlation, whereas percentage of powdery mildew intensity showed positive correlation with fruit yield. Fruit length showed positive but non-significant correlation with fruit yield.

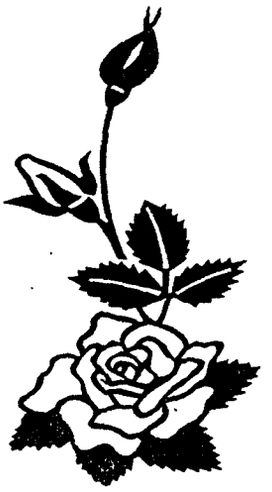
Shanti Priya (2001) in evaluation of watermelon observed significant and positive correlation of mean weight of fruit, length of vine, number of primary branches and 100 seed weight with yield per vine at both genotypic and phenotypic levels. Number of fruits showed negative and significant correlation with yield per vine at genotypic level. Close interrelationship was observed between days to first male flower opening and days to first female flower opening, length of main vine and mean weight of

fruit, node at which first male flower opening and first female flower opening, mean weight of fruit and 100 seed weight.

Chowdhury and Sarma (2002) the correlation coefficients revealed that yield per hectare can be improved through selection for greater fruit number per plant, fruit length and girth and individual fruit weight in ridge gourd.

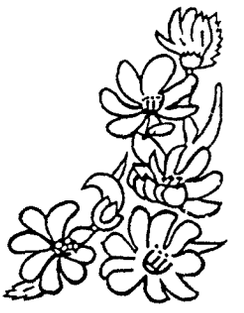
Dora *et al.* (2002) reported the yield per plant was significantly and positively correlated with number of fruits per plant, fruit set percentage and fruit retention percentage both at genotypic and phenotypic levels, while number of branches per plant, diameter of fruit, fruit length and days taken from fruit set to marketable maturity showed non-significant positive correlation with yield per plant in pointed gourd.

Torkadi (2003) recorded the weight of fruits per vine was positively correlated with average weight of fruit, pulp thickness, fruit cavity, weight of seeds per fruit, at genotypic level. These, characters can be considered as yield contributing characters in muskmelon. The weight of fruits per vine had positive and significant correlation with average weight of fruit, pulp thickness and PDI at phenotypic level and significant and negative correlation with days to first harvest and T.S.S. at genotypic level. The number of fruits per vine showed significant and negative correlation with average weight of fruit, length of fruit, diameter of fruit, pulp thickness fruit cavity, weight of seeds per fruit, F : C ratio and weight of 100 seeds.



MATERIAL AND METHODS





3. MATERIAL AND METHODS

The present investigation entitled, 'Studies on genetic variability in cucumber (*Cucumis sativus* L.)' was conducted at All India Co-ordinated Vegetable Improvement Project, Department of Horticulture, Central Campus, Mahatma Phule Krishi Vidyapeeth, Rahuri during summer 2006.

The details of the material used, methods adopted and statistical analysis followed during the course of this investigation are described below.

3.1 Material

The material under investigation consisted of Eighteen genotypes, collected from local areas coded and maintained at All India Co-ordinated Vegetable Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri. The genotypes were studied for different diverse characters.

The details of germplasm of cucumber and their sources are given in Table 1.

3.2 Methods

Seeds of 18 genotypes of cucumber were directly sown during summer 2006 season in Randomized Block Design with 2 replications to study the genetic variability.

Sowing of seed of each genotype was done, on the top of ridges. The ridges were prepared by keeping the distance of 2.0 m between two ridges. The distance between two vines were kept 0.5 m. Each genotype consisted of a single row of ten vines

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Table 1. Name of the genotypes and their sources

Sr. No.	Name of genotypes	Source
1.	Himangi	M.P.K.V., Rahuri
2.	Phule Shubhangi	M.P.K.V., Rahuri
3.	SNG-1	Kawathe Local (Sangli)
4.	SNG-2	Kawathepiran (Sangli)
5.	SNG-4	Samdoli (Sangli)
6.	SNG-5	Doodhgaon (Sangli)
7.	KOP-1	Ichalkaranji
8.	MLKP	Malkapur
9.	KDWD-1	Kurundwad
10.	KOP-2	Kagal village (Kolhapur)
11.	Panvel	Konkan (Panvel)
12.	J-04	Jalna Local
13.	Poona Khira	Pune
14.	J-02	Jalna Local
15.	Sheetal	Dr. B.S.K.K.V., Dapoli
16.	PLK	Narayangaon (Pune)
17.	Poinsette	P.D.V.R., Varanasi
18.	Improved Long Green	P.D.V.R., Varanasi

accommodated in a plot of 2.00 x 5.00 m. The five vines were randomly selected for recording the observations. These observational vines also score for downy mildew disease resistance as per 0-5 rating scale under natural epiphytotic conditions.

All cultural practices i.e. manuring, irrigation, plant protection, weeding etc. were carried out as per the prescribed package of practices recommended by the department.

3.3 Observations recorded

The observations for morphological, quantitative and qualitative characters were recorded on randomly selected 5 plants of each genotype in each replication.

3.3.1 Quantitative characters

1. Days to appearance of first male flower

The number of days required for the appearance of first male flower after sowing were recorded.

2. Days to appearance of first female flower

The number of days required for the appearance of the first female flower after sowing were recorded.

3. Node number of first female flower

The node at which the first female flower appeared was recorded.

4. Days to first harvest

Days to first harvest was recorded on the basis of number of days required for the first harvest of tender fruit from the date of sowing.

5. Number of fruits per vine

The total number of fruits harvested at all the harvestings of each observational plant were recorded and the average number of fruits per vine was worked out.

6. Weight of fruit (g)

Weight of fruit was calculated by dividing the total weight of all the fruits harvested to the total number of fruits.

7. Length of fruit (cm)

The length of five randomly selected fruits from the observational plants from each replication was measured in cm from the blossom end to the distal end of the fruit.

8. Diameter of fruit (cm)

Diameter of five randomly selected fruits from observational plants in each replication was measured at the center of the fruit using vernier caliper and mean diameter was calculated.

9. Thickness of flesh (cm)

Flesh thickness was measured by cutting the fruit at centre into two halves.

10. Core diameter (cm)

Core diameter was measured by cutting the fruit at centre into two halves.

11. Yield per vine (kg)

The yield of fruit at each harvesting from five observational plants were recorded from the first to last harvesting and mean yield of fruits per plant was calculated.

12. Final vine length (cm)

The height of five randomly selected observational plants was measured from ground level to tip of the main vine in cm. when the vine had attained its full maturity. From this, mean vine length was calculated.

13. Percent disease intensity of downy mildew (PDI %)

The observations for downy mildew incidence were recorded throughout the season to identify the downy mildew resistant genotypes (or to detect the severity of disease in different genotypes). The data was recorded as per 0-5 scale for downy mildew (Singh *et al.,* 1996 and Dhillon *et al.* 1999) as given below.

Numerical scale used	Per cent leaf area affected	Disease reaction
0	0	Immune
1	0.1-10	Highly resistant
2	10.1 to 25	Resistant
3	25.1 to 50	Moderately resistant
4	50.1 to 75	Susceptible
5	75.1 to 100	Highly susceptible

Percent Disease Intensity (PDI %) was calculated with the help of following formula.

$$\text{PDI \%} = \frac{\text{Sum of numerical ratings}}{\text{Total number of leaves examined} \times \text{Maximum rating}} \times 100$$

14. Incidence of pest

The occurance of pests like Aphids, Fruit fly and leaf miner were observed.

3.3.2 Qualitative characters

1. Colour of fruit

The fruit colour was recorded on the basis of visual observation as light green, medium green, dark green, yellowish white.

2. Surface of fruit

It was recorded by visual observations as smooth and rough.

3. Spine presence or absence

Spine presence or absence was recorded by visual observation.

4. Spine density

Spine density was recorded on the basis of visual observations as sparse, medium, high.

5. Size of fruit

Size of fruit was recorded on the basis of visual observation as short, medium long and long.

6. Keeping quality

Freshly harvested five fruits from each treatment were kept at room temperature to study their keeping quality and shelf life. The change in colour, crispness, taste and palatability was recorded periodically.

3.4 Statistical methodology

3.4.1 Analysis of variance

The analysis of variance was done as per Panse and Sukhatme (1985). The data was subjected to computer analysis

viz., variation due to replication, treatment and error. Significance of treatment effects were tested by 'F' test.

3.4.2 Genotypic and phenotypic coefficients of variation

The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were worked out by the formulae suggested by Burton and De Vane (1953).

$$GCV = \frac{\sqrt{\sigma_g^2}}{\bar{X}} \times 100$$

$$PCV = \frac{\sqrt{\sigma_p^2}}{\bar{X}} \times 100$$

Where,

$\bar{X}$ = General mean of the character

σ_g^2 = Genotypic variance

σ_p^2 = Phenotypic variance

3.4.3 Heritability percentage (Broad sense)

The heritability percentage in broad sense was estimated by the formula suggested by Burton and De Vane (1953).

$$h^2_{bs} = \frac{V_G}{V_P} \times 100$$

Where,

h^2_{bs} = Heritability in broad sense

V_G = Genotypic variance as obtained below

$$V_G = \frac{\text{Treatment MSS} - \text{Error MSS}}{\text{Number of replications}}$$

V_P = Phenotypic variance

$V_P = V_G + V_E$

3.4.4 Genetic advance (GA)

It was worked out as per the method given by Lush (1949).

$$GA = K \times \frac{V_G}{V_P} \times \sqrt{V_P}$$

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

Where,

V_G = Genotypic variance

V_P = Phenotypic variance

K = Selection differential at 5 per cent selection intensity (i.e. 2.06)

$\bar{X}$ = General mean of character

3.4.5 Correlation coefficient

In order to study the inter-relationship between different characters, the genotypic and phenotypic correlation coefficients were calculated for different pairs of characters involving (13) characters. Correlation coefficients were worked out by the following formulae.

$$r_g = \frac{\text{Co-variance XY (G)}}{\sqrt{\text{Variance X (G). Variance Y (G)}}}$$

$$r_{ph} = \frac{\text{Co-variance XY (PH)}}{\sqrt{\text{Variance X (PH)} \cdot \text{Variance Y (PH)}}}$$

Where,

r_g = Genotypic correlation coefficient between characters X and Y

r_{ph} = Phenotypic correlation coefficient between characters X and Y

X:Y = Two variables under consideration.

The correlation coefficients were compared with table value of correlation coefficient at 1 per cent and 5 per cent level of significance (Snedecor and Cochran, 1967).

3.4.6 D^2 analysis

The generalized distance between any two populations is defined as.

$$\Delta^2 = \Sigma\Sigma \lambda_{ij} \sigma^i \sigma^j$$

Where,

λ_{ij} = Reciprocal matrix to the common dispersion matrix

σ^i = Difference between the mean values of the two populations for i^{th} character.

This quantity is estimated by the D^2 statistic (Mujumdar and Rao, 1958).

$$D^2 = \Sigma\Sigma \ S_{ij} \sigma^i \sigma^j$$

Where,

S_{ij} = Sample estimates of λ_{ij}

σ^i = Sample estimate of σ^i

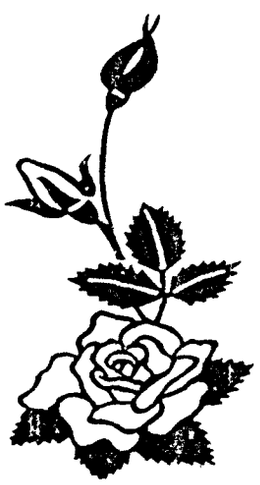
This formula requires the inversion of 13th order of determinant and the evaluation of 13 (13 + ½) terms whose sum is D^2.

3.4.7 Determination of population constellation

Since cluster is not a well defined term, no rigid rules are laid down for forming the clusters. The principle criterion, however, is that any two groups from same cluster should have on an average smaller D^2 value than those belonging to different clusters.

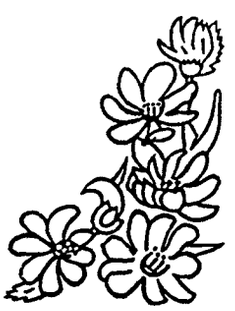
A method suggested by Tocher (Rao, 1952) was used for grouping the varieties into cluster. Accordingly, two closely associated groups were chosen and the third one having the smallest average from them was added to them. Similarly, the fourth having the smallest average D^2 from the first three was chosen and it was continued till a stage when the average D^2 of a genetic stock appeared to be high from those already grouped together. Then this stock was taken to be outside the cluster. Thus, one cluster was formed.

The genotypes included in the first cluster were then omitted and the rest were treated similarly.



EXPERIMENTAL RESULTS





4. EXPERIMENTAL RESULTS

The results of the present investigation entitled 'Studies on genetic variability in Cucumber (*Cucumis sativus* L.)' for summer season by using 18 diverse genotypes have been presented under the following heads.

4.1 Qualitative characters

The observations recorded on qualitative characters namely colour of fruit, surface of fruit, presence or absence of spine, spine density, size of fruit, keeping quality (days) are presented in Table 2.

4.2 Analysis of variance

The analysis of variance of thirteen characters is presented in Table 3. The analysis revealed that highly significant differences among 18 genotypes for all the thirteen characters studied which indicated presence of appreciable amount of variation among genotypes.

4.3 Range of variability and mean performance

Range of variability and mean performance of 18 genotypes for thirteen characters are presented in Table 5 and 4-

1. Days to appearance of first male flower

The days to appearance of first male flower ranged from 31.0 days (Himangi) to 48.0 days (MKLP) among the genotypes. Out of 18 genotypes, 7 genotypes were early and 11 genotypes were late for this trait. The genotypes PLK (36.6 days)

Table 2. Qualitative characters of fruits of the genotypes under study

Sr. No.	Name of genotypes	Colour of fruit	Surface of fruit	Spine presence or absence	Spine density	Size of fruit	Keeping quality (days)
1.	Himangi	White	Smooth	Present	Medium	Short	7
2.	Phule Shubhangi	Green	Smooth	Present	Medium	Short	7
3.	SNG-1	Light green	Medium rough	Absent	-	Medium long	3
4.	SNG-2	Green	Medium rough	Absent	-	Medium long	3
5.	SNG-4	Dark green	Medium rough	Absent	-	Medium long	3
6.	SMG-5	Green	Medium rough	Absent	-	Medium long	3
7.	KOP-1	Light green	Medium rough	Absent	-	Long	4
8.	MLKP	Light green	Medium rough	Absent	-	Long	3
9.	KDWD-1	Green	Medium rough	Absent	-	Medium long	4
10.	KOP-2	Green	Medium rough	Absent	-	Long	3
11.	Panvel	Light green	Smooth	Present	Medium	Medium long	4
12.	J-04	Greenish white	Smooth	Present	High	Very short	4
13.	Poona Khira	Yellowish white	Smooth	Present	High	Very short	3
14.	J-02	Whitish green	Smooth	Present	Medium	Short	3
15.	Sheetal	Green	Smooth	Present	Medium	Short	4
16.	PLK	Whitish yellow	Smooth	Present	Medium	Short	3
17.	Poinsette	Dark green	Smooth	Present	Medium	Short	6
18.	Improved Long Green	Green	Smooth	Present	Medium	Long	4

Table 3. Analysis of variance for different characters

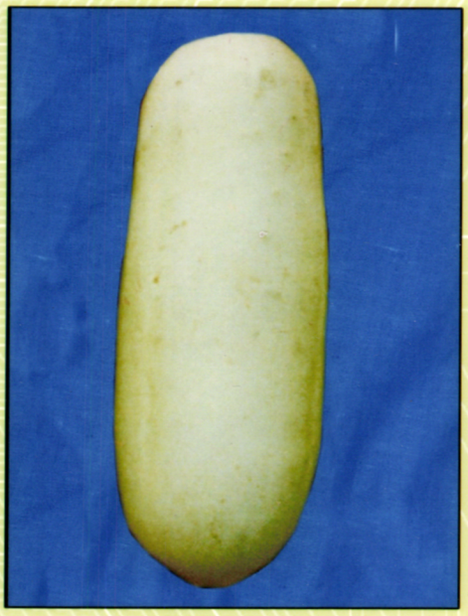
Sr. No.	Name of characters	Mean sum of squares		
		Replication	Treatment	Error
1.	Days to appearance of first male flower	0.903	37.743**	1.028
2.	Days to appearance of first female flower	0.423	63.558**	0.707
3.	Node number of first female flower	0.080	5.087**	0.141
4.	Days to first harvest	1.138	66.388**	0.462
5.	Number of fruits per vine	0.023	3.719**	0.091
6.	Weight of fruit (g)	56.250	2394.126**	20.191
7.	Length of fruit (cm)	0.107	43.180**	0.321
8.	Diameter of fruit (cm)	0.027	0.403**	0.012
9.	Thickness of flesh (cm)	0.001	0.030**	0.002
10.	Core diameter (cm)	0.015	0.162**	0.003
11.	Yield per vine (kg)	0.001	0.064**	0.002
12.	Final vine length (cm)	100.00	2550.785**	38.806
13.	PDI (%)	0.001	63.626**	0.519

*, ** indicates significance at 5 and 1 per cent level, respectively

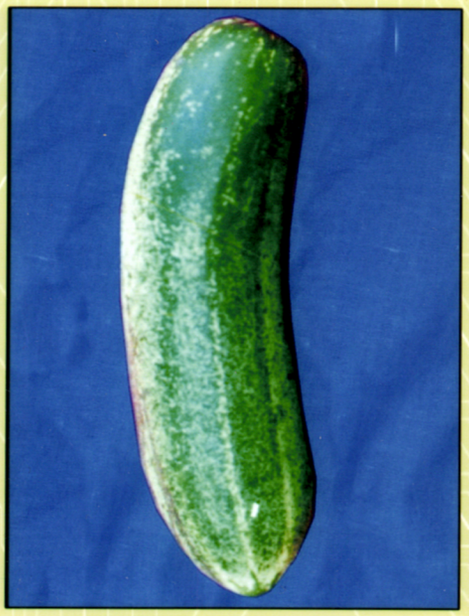
Table 4. Mean performance of genotypes in cucumber

Sr. No.	Name of the genotypes	Days to appearance of first male flower	Days to appearance of first female flower	Node number of first female flower	Days to first harvest	Number of fruits per vine	Weight of fruit (g)	Length of fruit (cm)	Diameter of fruit (cm)	Thickness of flesh (cm)	Core diameter (cm)	Yield per vine (kg)	Final vine length (cm)	PDI (%)
1.	Himangi	31.00	40.65	6.5	52.85	7.45	142.5	14.10	4.36	1.19	1.96	1.05	154.0	15.59
2.	Phule Shubhangi	37.75	43.40	7.6	54.75	7.85	175.0	16.62	4.50	1.17	2.17	1.34	164.0	14.07
3.	SNG-1	45.35	54.70	8.6	65.30	6.50	135.0	18.09	4.05	1.12	1.82	0.87	182.6	22.00
4.	SNG-2	46.45	54.40	8.7	63.95	6.30	127.50	18.70	3.50	1.07	1.36	0.80	170.0	19.59
5.	SNG-4	41.50	46.30	6.4	59.70	6.90	137.50	20.55	4.30	1.05	2.22	0.94	207.45	14.21
6.	SNG-5	39.00	43.60	6.0	55.05	7.70	142.50	19.05	4.65	1.12	2.39	1.07	206.05	13.16
7.	KOP-1	45.10	57.20	8.75	68.10	5.80	142.50	27.75	4.60	1.15	2.37	0.83	207.95	11.43
8.	MLKP	48.00	55.00	10.40	69.30	5.40	149.00	22.85	3.70	0.95	1.92	0.79	221.70	16.20
9.	KDWD-1	42.50	51.10	7.50	64.40	5.50	135.00	17.98	4.25	1.02	2.15	0.74	229.95	18.21
10.	KOP-2	41.70	48.50	8.60	62.30	6.85	147.50	26.68	4.20	1.12	2.02	0.99	245.15	12.12
11.	Panvel	41.60	49.10	9.05	61.70	3.50	237.50	21.90	4.95	1.29	2.40	0.82	189.40	26.29
12.	J-04	41.75	48.50	8.25	61.20	6.20	134.00	15.60	4.00	1.00	2.10	0.81	196.50	24.75
13.	Poona Khira	37.05	39.05	5.95	51.80	4.70	130.00	12.75	4.15	0.95	2.23	0.60	99.00	25.18
14.	J-02	47.25	49.40	7.40	63.35	6.75	132.50	11.47	3.70	0.95	1.82	0.89	158.90	22.59
15.	Sheetal	41.60	47.50	7.40	58.05	5.10	146.50	16.70	4.65	1.15	2.35	0.74	146.50	22.14
16.	PLK	36.60	44.70	6.0	56.40	5.25	202.50	17.50	4.75	1.13	2.46	1.06	164.45	16.57
17.	Poinsette	38.65	44.95	5.05	57.00	5.80	177.50	15.75	4.60	1.17	2.27	1.03	164.25	8.47
18.	Improved Long Green	44.60	58.90	11.00	72.20	2.70	235.00	26.00	5.20	1.43	2.47	0.65	217.05	27.34
	Mean	41.52	48.71	7.73	60.96	5.90	157.19	18.89	4.33	1.11	2.13	0.89	184.71	18.33
	S.E. ±	0.71	0.59	0.26	0.48	0.21	3.17	0.40	0.07	0.02	0.03	0.03	4.40	0.50
	CD at 5 %	2.13	1.77	0.79	1.43	0.63	9.48	1.19	0.23	0.08	0.10	0.09	13.14	1.51

PLATE 1



Himangi



Phule Shubhangi



SNG-1



SNG-2



SNG-4



SNG-5



KOP-1



MLKP-1



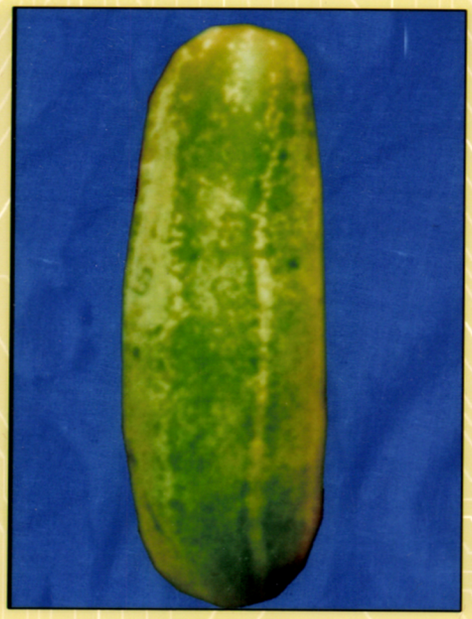
KDWD-1

PLATE 2

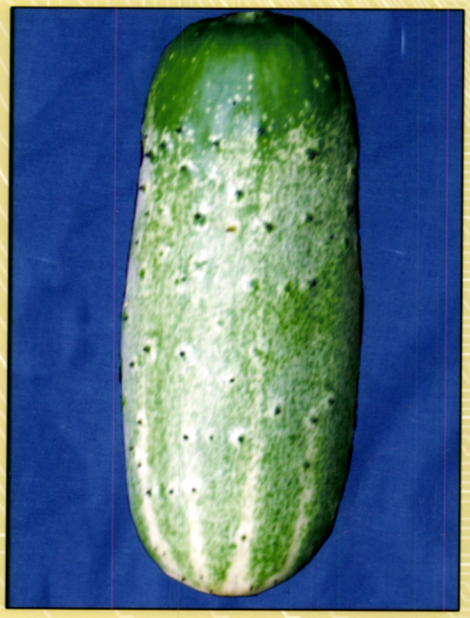
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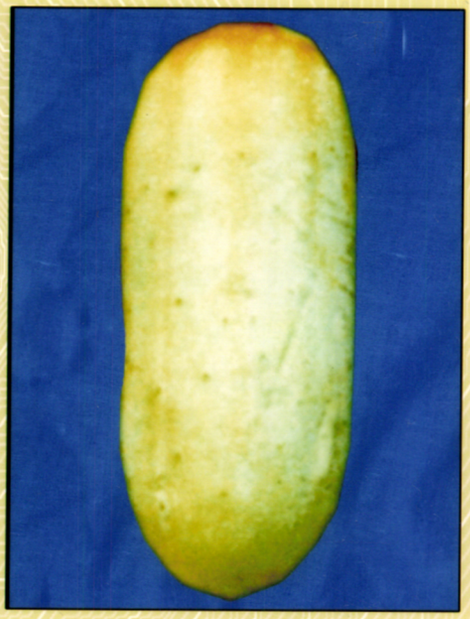
KOP-2



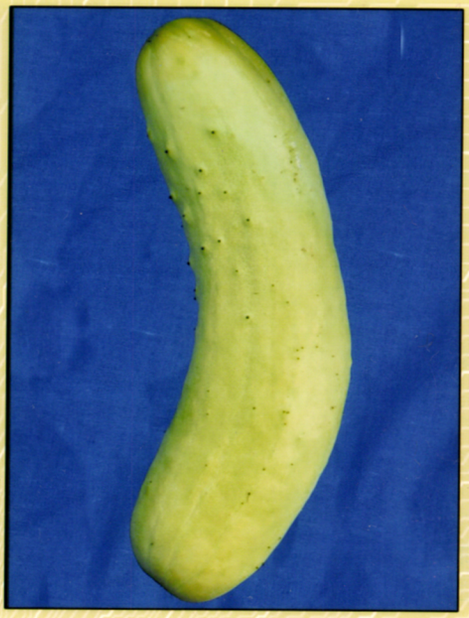
Panvel



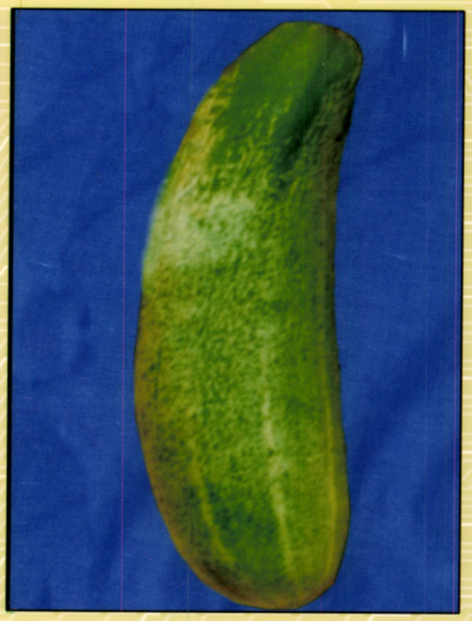
J-04



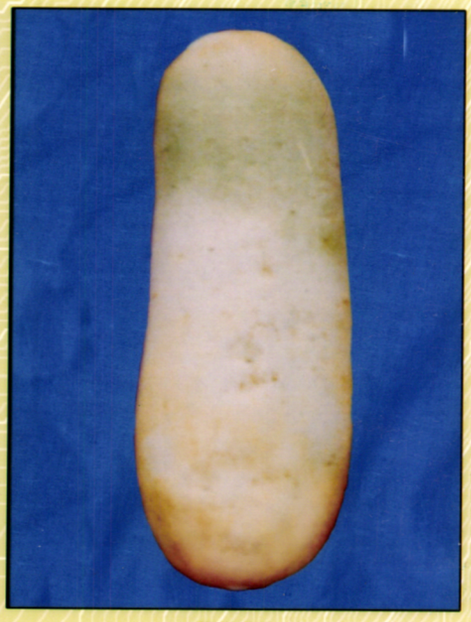
Poona Khira



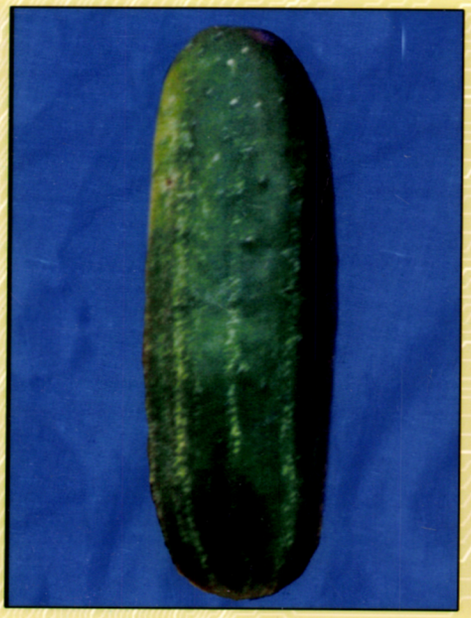
J-02



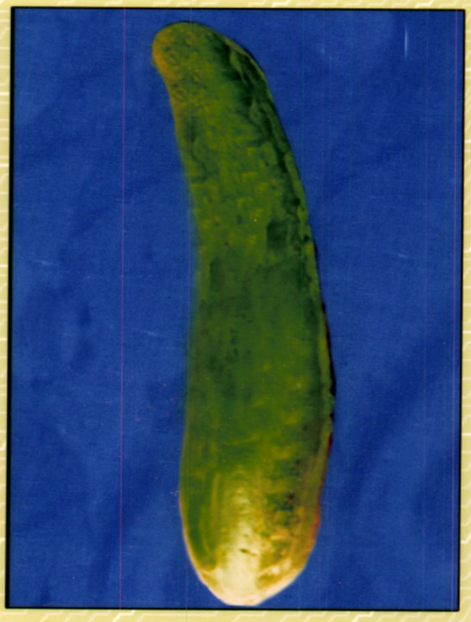
Sheetal



PLK



Poinsette



Improved Long Green

and Poona Khira (37.05 days) were earlier as compared to population mean 41.42 days.

2. Days to appearance of first female flower

The days to appearance of first female flower ranged from 39.04 days (Poona Khira) to 58.90 days (Improved Long Green) among the genotypes. Out of 18 genotypes, 10 genotypes were early and 8 genotypes were late for this trait. The genotypes Himangi (40.65 days), Phule Shubhangi (43.40 days) and SNG-5 (43.60 days) were earlier whereas, KOP-1 (57.20 days), MLKP (55.00 days) and SNG-1 (54.70 days) were late as compared to population mean 48.71 days for this trait.

3. Node number of first female flower

The variation for node number of first female flower ranged between 5.05 (Poinsette) and 11.0 (Improved Long Green), while population mean for this character was 7.73. Poona Khira recorded node number (5.95), SNG-5 (6.0) and PLK (6.0) for first female flower.

4. Days to first harvest

The average days to first harvest was recorded 60.96 days in the present investigation. The variation for days to first harvest ranged between 51.80 days (Poona Khira) and 72.20 days (Improved Long Green). The genotypes MLKP (69.30 days), KOP-1 (68.10 days) and SNG-1 (65.30 days) required maximum days for first harvest, while the genotypes. Himangi (52.85 days) and Phule Shubhangi (54.75 days) were required minimum days for this trait.

5. Number of fruits per vine

The number of fruits per vine varied from 2.70 (Improved Long Green) to 7.85 (Phule Shubhangi). The average number of fruits per vine was 5.90. The genotypes SNG-5 (7.70), Himangi (7.45) and SNG-4 (6.90) had maximum number of fruits per vine. While, the genotypes Panvel (3.5), Poona Khira (4.7) and Sheetal (5.1) had minimum number of fruits per vine.

6. Weight of fruit

The weight of fruit varied from 127.50 g (SNG-2) to 237.50 g (Panvel). The genotypes Improved Long Green (235 g) and PLK (202.50 g) had maximum weight of fruit. While, genotypes Poona Khira (130.00 g) and J-02 (132.50 g) had minimum weight of fruit as compared to population mean 157.19 g.

7. Length of fruit

The variation for fruit length ranged between 11.47 cm (J-02) and 27.75 cm (KOP-1). The average length of fruit was 18.89 cm. Among 18 genotypes, 11 genotypes had shorter fruits, while 7 genotypes had longer fruit over the mean fruit length. The genotypes KOP-2 (26.68 cm) and Improved Long Green (26.0 cm) had bigger fruit length.

8. Diameter of fruit

The diameter of fruit varied from 3.5 cm (SNG-2) to 5.2 cm (Improved Long Green) among the studied genotypes. The average diameter of fruit was 4.33 cm. The genotypes Panvel (4.95 cm) and PLK (4.75 cm) were recorded for maximum

diameter of fruit. While, MLKP (3.7 cm), J-02 (3.7 cm) and J-04 (4.00 cm) were recorded for minimum diameter of fruit.

9. Thickness of flesh

The thickness of flesh varied from 0.95 cm (MLKP, Poona Khira and J-02) to 1.43 cm (Improved Long Green). The genotypes Panvel (1.29 cm) and Himangi (1.19 cm) had maximum flesh thickness of fruit. While, J-04 (1.00 cm), KDWD-1 (1.02 cm) and SNG-4 (1.05 cm) had minimum flesh thickness as compared to population mean 1.11 cm.

10. Core diameter

The variation for core diameter of fruit ranged between 1.36 cm (SNG-2) and 2.47 cm (Improved Long Green). The genotypes PLK (2.46 cm), Panvel (2.40 cm) and SNG-5 (2.39 cm) had maximum core diameter of fruit. While SNG-1 (1.82 cm), J-02 (1.82 cm) and MLKP (1.92 cm) had minimum core diameter of fruit as compared to population mean of 2.13 cm.

11. Yield per vine

The fruit yield per vine ranged from 0.60 kg (Poona Khira) to 1.34 kg (Phule Shubhangi). 8 genotypes had comparatively higher fruit yield than the population mean of 0.89 kg. The genotypes SNG-5 (1.07 kg), PLK (1.06 kg) and Himangi (1.05 kg) had maximum yield per vine, while genotypes Improved Long Green (0.65 kg), KDWD-1 (0.74 kg) and Sheetal (0.74 kg) were recorded for minimum yield per vine.

12. Final vine length

The final vine length ranged from 99 cm (Poona Khira) to 245.15 cm (KOP-2). Among the 18 genotypes of cucumber, 9

genotypes had greater final vine length and 9 genotypes had lesser final vine length over the mean vine length 184.71 cm. The genotypes KDWD-1 (229.95 cm), MLKP (221.70 cm) and Improved Long Green (217.05 cm) were recorded for maximum final vine length.

13. Per cent disease intensity

The per cent disease intensity ranged from 8.47 per cent (Poinsette) to 27.34 per cent (Improved Long Green). The genotypes KOP-1 (11.43 %), KOP-2 (12.12 %) and SNG-5 (13.16 %) had minimum per cent disease intensity as compared to population mean 18.33 per cent.

Variation among different genotypes showed in Plate 1 and 2.

4.4 Genotypic and phenotypic coefficients of variation

The estimates of genotypic coefficients of variation were low as compared to phenotypic coefficient variation for all the characters under study (Table 5). The phenotypic and genotypic coefficient of variation was high for PDI (30.76 and 30.64) followed by length of fruit (24.59 and 24.50), number of fruits per vine (23.10 and 22.81), weight of fruit (22.01 and 21.91) and node number of first female flower (20.62 and 20.34).

The lowest PCV and GCV were observed for days to first harvest (9.45 and 9.41) followed by diameter of fruit (10.34 and 10.18) and days to appearance of first male flower (10.46 and 10.31).

Table 5. Variability parameters for different characters in cucumber

Sr. No.	Name of character	Range	Mean	PCV %	GCV %	Heritability % (B.S.)	Genetic advance	GA as % of mean
1.	Days to appearance of first male flower	31.0-48.0	41.52	10.46	10.31	97.3	8.70	20.96
2.	Days to appearance of first female flower	39.05-58.90	48.71	11.57	11.50	98.9	11.48	23.57
3.	Node number of first female flower	5.05-11.0	7.73	20.62	20.34	97.2	3.19	41.31
4.	Days to first harvest	51.80-72.20	60.96	9.45	9.41	99.3	11.78	19.33
5.	Number of fruits per vine	2.70-7.85	5.90	23.10	22.81	97.6	2.74	46.42
6.	Weight of fruit (g)	127.50-237.50	157.19	22.01	21.91	99.2	70.67	44.95
7.	Length of fruit (cm)	11.47-27.75	18.89	24.59	24.50	99.3	9.50	50.29
8.	Diameter of fruit (cm)	3.5-5.2	4.33	10.34	10.18	96.9	0.89	20.64
9.	Thickness of flesh (cm)	0.95-1.43	1.11	10.97	10.65	94.2	0.23	21.30
10.	Core diameter (cm)	1.36-2.47	2.13	13.29	13.18	98.4	0.57	26.94
11.	Yield per vine (kg)	0.60 – 1.34	0.89	20.02	19.73	97.1	0.35	40.04
12.	Final vine length (cm)	99.00-245.15	184.71	19.33	19.18	98.5	72.44	39.22
13.	PDI (%)	8.47-27.34	18.33	30.76	30.64	99.2	11.52	62.86

4.5 Heritability and genetic advance

The heritability (Broad sense) percentage ranged between 94.2 and 99.3 (Table 5). High heritability (B.S.) percentage was observed for all the characters. Comparatively high heritability (B.S.) was observed, same 99.3 per cent for days to first harvest and length of fruit followed by 99.2 per cent for weight of fruit and PDI, 98.9 per cent for days to appearance of first female flower, 98.5 per cent for final vine length and 98.4 per cent for core diameter.

The genetic advance varied from 0.23 for thickness of flesh to 72.44 for final vine length. The genetic advance expressed as percentage of mean, however ranged from 19.33 for days to first harvest to 62.86 for PDI.

The character of final vine length showed maximum genetic advance (72.44) followed by weight of fruit (70.67). Moderate genetic advance was observed for days to first harvest (11.78), PDI (11.52) and days to appearance of first female flower (11.48) whereas, the lower value was recorded for thickness of flesh (0.23) followed by yield per vine (0.35), core diameter (0.57)and diameter of fruit (0.89).

High heritability followed by high percentage of genetic advance was observed in the characters like weight of fruit and final vine length.

4.6 Phenotypic and genotypic correlations

The magnitude of genotypic correlation coefficient in general was higher than the phenotypic correlation coefficient (Table 6).

The days to appearance of first male flower exhibited significant and positive correlation with days to appearance of first female flower, node number of first female flower and days to first harvest at both genotypic and phenotypic levels. It was significantly and negatively correlated with yield per vine at both genotypic and phenotypic levels. It showed non-significant but positive correlation with length of fruit, final vine length and PDI at both genotypic and phenotypic levels. Whereas it was non-significantly and negatively correlated with number of fruits per vine, weight of fruit, diameter of fruit, thickness of flesh and core diameter at both genotypic and phenotypic levels.

The days to appearance of first female flower were significantly and positively correlated with node number of first female flower, days to first harvest, length of fruit and final vine length at both genotypic and phenotypic levels. While, it was non-significantly but positively correlated with weight of fruit, thickness of flesh and PDI at both genotypic and phenotypic levels. It was non-significant and negatively correlated with number of fruits per vine, diameter of fruit, core diameter and yield per vine at both genotypic and phenotypic levels.

The node number of first female flower exhibited significant and positive correlation with days to first harvest, length of fruit and final vine length at both genotypic and

Table 6. Estimates of genotypic (G) and phenotypic (P) correlations

Sr. No.	Name of character		1	2	3	4	5	6	7	8	9	10	11	12	13
1.	Days to appearance of first male flower	P	-	0.843**	0.674**	0.849**	-0.239	-0.116	0.392	-0.396	-0.193	-0.362	-0.457*	0.431	0.239
		G	-	0.862**	0.690**	0.864**	-0.251	-0.118	0.402	-0.401	-0.184	-0.371	-0.477*	0.442	0.247
2.	Days to appearance of first female flower	P			0.826**	0.973*	-0.392	0.135	0.640**	-0.083	0.212	-0.201	-0.442	0.575*	0.202
		G			0.845**	0.984**	-0.397	0.139	0.646**	-0.082	0.219	-0.208	-0.449	0.578**	0.200
3.	Node number of first female flower	P				0.846**	-0.438	0.272	0.634**	-0.054	0.273	-0.183	-0.404	0.520*	0.409
		G				0.857**	-0.449	0.276	0.641**	-0.058	0.293	-0.189	-0.414	0.538*	0.414
4.	Days to first harvest	P					-0.425	0.158	0.647**	-0.097	0.156	-0.163	-0.470*	0.646**	0.218
		G					-0.436	0.157	0.650**	-0.097	0.162	-0.168	-0.484*	0.659**	0.217
5.	Number of fruits per vine	P						-0.641**	-0.302	-0.445	-0.406	-0.406	0.706**	0.00	-0.603**
		G						-0.649**	-0.305	-0.456*	-0.413	-0.419	0.703**	-0.002	-0.608**
6.	Weight of fruit (g)	P							0.336	0.759**	0.783**	0.571*	0.064	0.106	0.230
		G							0.337	0.780**	0.810**	0.577**	0.061	0.111	0.230
7.	Length of fruit (cm)	P								0.327	0.445	0.241	-0.131	0.752**	-0.197
		G								0.338	0.451	0.240	-0.135	0.765**	-0.200
8.	Diameter of fruit (cm)	P									0.811**	0.880**	0.109	0.068	0.010
		G									0.847**	0.905**	0.120	0.072	0.012
9.	Thickness of flesh (cm)	P										0.455	0.118	0.163	0.082
		G										0.475*	0.134	0.176	0.088
10.	Core diameter (cm)	P											0.032	0.058	-0.029
		G											0.026	0.064	-0.033
11.	Yield per vine (kg)	P												0.015	-0.649**
		G												0.014	-0.657**
12.	Final vine length (cm)	P													-0.257
		G													-0.258
13.	PDI (%)	P													
		G													

** Significant at 1 % * Significant at 5 %

phenotypic levels. It showed non-significant but positive correlation with weight of fruit, thickness of flesh and PDI at both genotypic and phenotypic levels and non-significant and negative correlation with number of fruits per vine, diameter of fruit, core diameter and yield per vine at both genotypic and phenotypic levels.

The days to first harvest showed significant and positive correlation with length of fruit and final vine length at both genotypic and phenotypic levels. It showed significant but negative correlation with yield per vine at both genotypic and phenotypic levels. It showed non-significant but positive correlation with weight of fruit, thickness of flesh and PDI at both genotypic and phenotypic levels and non-significant and negative correlation with number of fruits per vine, diameter of fruit, core diameter at both genotypic and phenotypic levels.

The number of fruits per vine showed significant and positive correlation with yield per vine at both genotypic and phenotypic levels. It showed significant but negative correlation with weight of fruit and PDI at both genotypic and phenotypic levels. It also showed significant but negative correlation with diameter of fruit at genotypic level and non-significant and negative correlation with diameter of fruit at phenotypic level. It showed non-significant and negative correlation with length of fruit, thickness of flesh and core diameter at both genotypic and phenotypic levels and non-significant and negative correlation with final vine length at genotypic level.

The weight of fruit had significant and positive correlation with diameter of fruit, thickness of flesh and core diameter at both genotypic and phenotypic levels. It showed non-significant and positive correlation with length of fruit, yield per vine, final vine length and PDI at both genotypic and phenotypic levels.

The length of fruit exhibited significant and positive correlation with final vine length at both genotypic and phenotypic levels. It showed non-significant but positive correlation with diameter of fruit, thickness of flesh and core diameter at both genotypic and phenotypic levels and non-significant and negative correlation with yield per vine and PDI at both genotypic and phenotypic levels.

The diameter of fruit showed significant and positive correlation with thickness of flesh and core diameter at both genotypic and phenotypic levels. It showed non-significant but positive correlation with yield per vine, final vine length and PDI at both genotypic and phenotypic levels.

The thickness of flesh exhibited significant and positive correlation with core diameter at genotypic level. It showed non-significant but positive correlation with core diameter at phenotypic level and non-significant but positive correlation with yield per vine, final vine length and PDI at both genotypic and phenotypic levels.

The core diameter showed non-significant and positive correlation with yield per vine and final vine length at both genotypic and phenotypic levels. While, it showed non-

significant and negative correlation with PDI at both genotypic and phenotypic levels.

The yield per vine exhibited significant but negative correlation with PDI at both genotypic and phenotypic levels. While, it showed non-significant but positive correlation with final vine length at both genotypic and phenotypic levels.

The non-significant and negative correlation was observed between final vine length and PDI at both genotypic and phenotypic levels.

4.7 D^2 analysis

The calculated D^2 values for all possible combinations of 18 genotypes arranged in ascending order are presented in Table 7. The D^2 values ranged from 294.93 to 15976.42. The minimum D^2 value of 294.93 was noted between the genotype J-04 and Sheetal, while the maximum D^2 value of 15976.42 was observed between the genotype Improved Long Green and Poona Khira.

4.8 Cluster formation and inter and intra cluster divergence

Based on D^2 values (Table 7, 8 and Fig. 1) eight clusters were formed among the eighteen genotypes. Out of these eight clusters, cluster A and B were the largest having 5 genotypes each which was followed by cluster E having 3 genotypes. The remaining clusters C, D, F, G and H had a single genotype each indicating wide divergence among the genotypes.

Table 7. D^2 values of 18 genotypes arranged in ascending order

	Himangi		Phule Shubhangi		SNG-1		SNG-2		SNG-4		SNG-5
Himangi	0	Phule Shubhangi	0.00	SNG-1	0.00	SNG-2	0.00	SNG-4	0.00	SNG-5	0.00
Phule Shubhangi	447.41	Himangi	447.41	SNG-2	315.79	SNG-1	315.79	SNG-5	385.07	SNG-4	385.07
Poona Khira	805.19	PLK	531.66	J-04	587.37	J-02	857.14	KDWD-1	556.25	PLK	490.74
Sheetal	1053.18	Sheetal	610.17	J-02	721.86	J-04	1172.80	KOP-2	746.16	Sheetal	548.34
PLK	1440.08	SNG-5	916.89	KDWD-1	845.12	SNG-4	1470.93	SNG-1	848.94	J-04	801.20
J-02	1540.67	Poinsette	1126.63	SNG-4	848.94	Sheetal	1565.80	J-04	861.92	Phule Shubhangi	916.89
SNG-5	1604.88	J-04	1186.94	Sheetal	991.91	KDWD-1	1740.96	Poinsette	935.62	Poinsette	972.75
J-04	1627.12	J-02	1287.41	SNG-5	1499.29	Poinsette	2169.35	Sheetal	942.03	SNG-1	1499.29
Poinsette	2129.34	SNG-4	1819.61	PLK	1646.59	SNG-5	2238.00	PLK	942.33	KDWD-1	1602.32
SNG-4	2814.19	Poona Khira	1962.67	Poinsette	1648.18	Phule Shubhangi	2319.14	SNG-2	1470.93	Himangi	1604.88
SNG-1	3006.53	SNG-1	1980.75	KOP-2	1729.56	PLK	2398.21	Panvel	1616.38	Panvel	1633.26
SNG-2	3029.27	SNG-2	2319.14	MLKP	1806.36	MLKP	2427.49	J-02	1795.20	J-02	1823.80
Panvel	4632.50	Panvel	2846.06	Panvel	1941.58	KOP-2	2452.67	Phule Shubhangi	1819.61	KOP-2	1873.31
KDWD-1	4774.37	KDWD-1	3357.65	Phule Shubhangi	1980.75	Himangi	3029.27	MLKP	1880.23	SNG-2	2238.00
KOP-2	6037.80	KOP-2	4249.54	Himangi	3006.53	Panvel	3337.43	KOP-1	2568.86	Poona Khira	3297.47
MLKP	8020.70	MLKP	5929.13	KOP-1	3362.79	KOP-1	4217.80	Himangi	2814.19	MLKP	3808.05
KOP-1	10044.68	KOP-1	7509.51	Improved long green	4617.47	Poona Khira	4829.12	Improved Long Green	4551.92	KOP-1	4607.33
Improved Long Green	12273.32	Improved Long Green	9079.36	Poona Khira	4921.82	Improved Long Green	6554.24	Poona Khira	4839.30	Improved Long Green	6163.18

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Table 7 contd.....

	KOP-1		MLKP		KDWD-1		KOP-2		Panvel		J-04
KOP-1	0.00	MLKP	0.00	KDWD-1	0.00	KOP-2	0.00	Panvel	0.00	J-04	0.00
MLKP	565.63	KOP-1	565.63	SNG-4	556.25	KDWD-1	731.96	PLK	1524.24	Sheetal	294.93
KOP-2	955.91	KDWD-1	716.71	MLKP	716.71	SNG-4	746.16	SNG-4	1616.38	J-02	462.86
KDWD-1	1600.39	KOP-2	863.27	KOP-2	731.96	MLKP	863.27	SNG-5	1633.26	SNG-1	587.37
Improved Long Green	2393.28	SNG-1	1806.36	SNG-1	845.12	KOP-1	955.91	Sheetal	1828.81	SNG-5	801.20
SNG-4	2568.86	SNG-4	1880.23	J-04	1359.56	SNG-1	1729.56	J-04	1841.76	SNG-4	861.92
SNG-1	3362.79	SNG-2	2427.49	Poinsette	1564.64	SNG-5	1873.31	KDWD-1	1860.55	PLK	1090.76
Poinsette	3955.77	Improved Long Green	2503.26	KOP-1	1600.39	Panvel	2098.95	SNG-1	1941.58	SNG-2	1172.80
Panvel	4133.84	Poinsette	3142.84	SNG-5	1602.32	Poinsette	2444.32	KOP-2	2098.95	Phule Shubhangi	1186.94
SNG-2	4217.80	Panvel	3378.83	SNG-2	1740.96	SNG-2	2452.67	Improved Long Green	2400.20	KDWD-1	1359.56
SNG-5	4607.33	J-04	3480.72	Panvel	1860.55	J-04	2628.21	Poinsette	2582.26	Himangi	1627.12
PLK	5109.18	SNG-5	3808.05	Sheetal	1888.88	PLK	2739.95	Phule Shubhangi	2846.06	Poinsette	1650.08
J-04	5365.35	PLK	4133.25	PLK	1961.40	Improved Long Green	2789.35	J-02	3313.10	Panvel	1841.76
Sheetal	5783.02	J-02	4201.75	J-02	2206.97	Sheetal	3079.79	SNG-2	3337.43	KOP-2	2628.21
J-02	6589.72	Sheetal	4270.74	Improved Long Green	2973.32	J-02	4064.87	MLKP	3378.83	Poona Khira	2763.35
Phule Shubhangi	7509.51	Phule Shubhangi	5929.13	Phule Shubhangi	3357.65	Phule Shubhangi	4249.54	KOP-1	4133.84	MLKP	3480.72
Himangi	10044.68	Himangi	8020.70	Himangi	4774.37	Himangi	6037.80	Himangi	4632.50	KOP-1	5365.35
Poona Khira	13808.42	Poona Khira	11280.71	Poona Khira	7199.12	Poona Khira	9105.41	Poona Khira	6785.29	Improved Long Green	6167.25

Table 7 contd.....

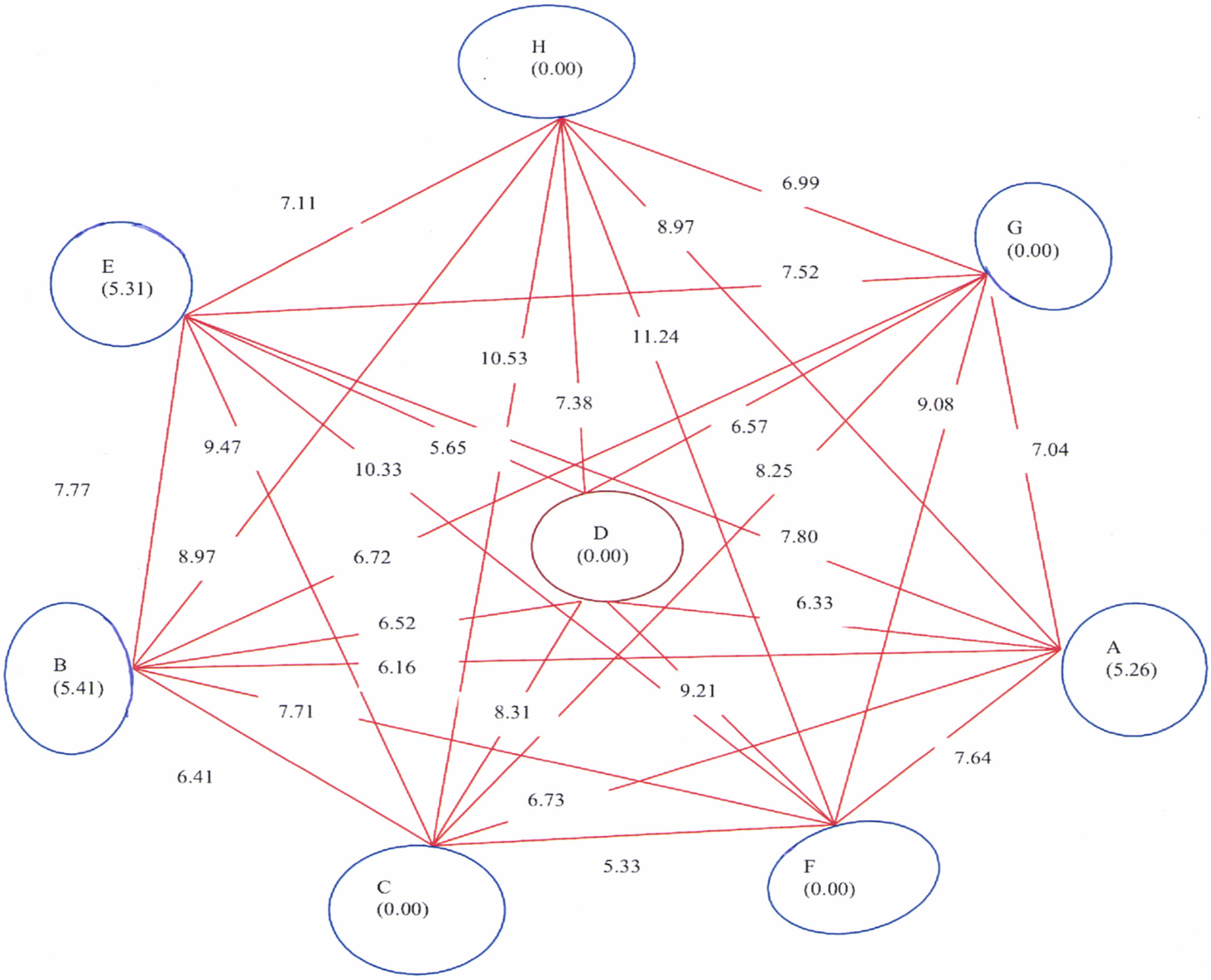
	Poona Khira		J-02		Sheetal		PLK		Poinsette		Improved Long Green
Poona Khira	0.00	J-02	0.00	Sheetal	0.00	PLK	0.00	Poinsette	0.00	Improved Long Green	0.00
Himangi	805.19	J-04	462.86	J-04	294.93	Poinsette	423.83	PLK	423.83	KOP-1	2393.28
Phule Shubhangi	1962.67	Sheetal	669.37	PLK	507.01	SNG-5	490.74	SNG-4	935.62	Panvel	2400.20
Sheetal	2017.59	SNG-1	721.86	SNG-5	548.34	Sheetal	507.01	SNG-5	972.75	MLKP	2503.26
J-02	2529.84	SNG-2	857.14	Phule Shubhangi	610.17	Phule Shubhangi	531.66	Sheetal	1098.82	KOP-2	2789.35
J-04	2763.35	Phule Shubhangi	1287.41	J-02	669.37	SNG-4	942.33	Phule Shubhangi	1126.63	KDWD-1	2973.32
PLK	3189.96	Himangi	1540.67	SNG-4	942.03	J-04	1090.76	KDWD-1	1564.64	SNG-4	4551.92
SNG-5	3297.47	PLK	1651.84	SNG-1	991.91	Himangi	1440.08	SNG-1	1648.18	SNG-1	4617.47
Poinsette	4373.22	SNG-4	1795.20	Himangi	1053.18	Panvel	1524.24	J-04	1650.08	SNG-5	6163.18
SNG-2	4829.12	Poinsette	1812.85	Poinsette	1098.82	SNG-1	1646.59	J-02	1812.85	J-04	6167.25
SNG-4	4839.30	SNG-5	1823.80	SNG-2	1565.80	J-02	1651.84	Himangi	2129.34	PLK	6218.82
SNG-1	4921.82	KDWD-1	2206.97	Panvel	1828.81	KDWD-1	1961.40	SNG-2	2169.35	Poinsette	6402.22
Panvel	6785.29	Poona Khira	2529.84	KDWD-1	1888.88	SNG-2	2398.21	KOP-2	2444.32	SNG-2	6554.24
KDWD-1	7199.12	Panvel	3313.10	Poona Khira	2017.59	KOP-2	2739.95	Panvel	2582.26	Sheetal	6853.08
KOP-2	9105.41	KOP-2	4064.87	KOP-2	3079.79	Poona Khira	3189.96	MLKP	3142.84	J-02	8117.13
MLKP	11280.71	MLKP	4201.75	MLKP	4270.74	MLKP	4133.25	KOP-1	3955.77	Phule Shubhangi	9079.36
KOP-1	13808.42	KOP-1	6589.72	KOP-1	5783.02	KOP-1	5109.18	Poona Khira	4373.22	Himangi	12273.32
Improved Long Green	15976.42	Improved Long Green	8117.13	Improved Long Green	6853.08	Improved Long Green	6218.82	Improved Long Green	6402.22	Poona Khira	15976.42

Table 8. Distribution of 18 genotypes in different clusters

Cluster	Genotypes number	Number of genotypes
A	12, 15, 14, 3, 4	5
B	5, 6, 16, 17,2	5
C	1	1
D	9	1
E	7, 8, 10	3
F	13	1
G	11	1
H	18	1

Note : Genotype numbers are according to Table 1.

Fig. 1. Genetic divergence (D) among group of 18 genotypes of cucumber.



Not to the scale

* Values in parenthesis are intra cluster values

The inter and intra cluster D^2 values are given in Table 9, while D values are presented in Table 10. The maximum inter cluster divergence (Table 10) was observed between the cluster F and H (11.24), while it was lowest between cluster C and F (5.33).

Out of twenty eight inter cluster combinations, eighteen combinations *viz.,* A with B, C, D, E, F, G; B with C, D, E, F, G; C with F; D with E, G, H; E with G, H; G with H were within the inter cluster divergence of 5.33 to 7.80.

The remaining ten inter cluster combinations *viz.,* A with H., B with H., C with D, E, G, H., D with F., E with F., F with G, H were within the inter cluster divergence of 8.31 to 11.24.

Intra cluster D values for the cluster A (5.26), B (5.41) and E (5.31) suggested substantial and almost equal diversity within themselves while the cluster C, D, F, G and H comprising of a single genotype each had no intra cluster divergence.

The mean values of thirteen characters for all clusters are presented in Table 11.

The cluster mean for days to appearance of first male flower was the highest in cluster E (44.93) followed by cluster H (44.60) and the lowest in the cluster C (31.00). The remaining cluster had intermediate mean values.

The cluster mean for days to appearance of first female flower was maximum in cluster H (58.90) followed by cluster E (53.57), D (51.10) and A (50.90). It was lowest in cluster F (39.05). The remaining clusters had intermediate mean values.

Table 9. Average inter and intra cluster D^2 values

	A	B	C	D	E	F	G	H
A	27.64	37.89	45.29	40.10	60.81	58.42	49.52	80.39
B		29.23	41.08	42.53	60.39	59.44	45.17	80.52
C			0.00	69.10	89.64	28.38	68.06	110.79
D				0.00	31.88	84.85	43.13	54.53
E					28.19	106.76	56.60	50.62
F						0.00	82.37	126.40
G							0.00	48.99
H								0.00

Table 10. Average inter and intra cluster D values

	A	B	C	D	E	F	G	H
A	5.26	6.16	6.73	6.33	7.80	7.64	7.04	8.97
B		5.41	6.41	6.52	7.77	7.71	6.72	8.97
C			0.00	8.31	9.47	5.33	8.25	10.53
D				0.00	5.65	9.21	6.57	7.38
E					5.31	10.33	7.52	7.11
F						0.00	9.08	11.24
G							0.00	6.99
H								0.00

Table 11. Cluster means for 13 characters

Sr. No.	Name of character	A	B	C	D	E	F	G	H
1.	Days to appearance of first male flower	44.48	38.70	31.00	42.50	44.93	37.05	41.60	44.60
2.	Days to appearance of first female flower	50.90	44.59	40.65	51.10	53.57	39.05	49.10	58.90
3.	Node number of first female flower	8.07	6.21	6.50	7.50	9.25	5.95	9.05	11.00
4.	Days to first harvest	62.37	56.58	52.85	64.40	66.57	51.80	61.70	72.20
5.	Number of fruits per vine	6.17	6.70	7.45	5.50	6.02	4.70	3.50	2.70
6.	Weight of fruit (g)	135.10	167.00	142.50	135.00	146.33	130.00	237.50	235.00
7.	Length of fruit (cm)	16.11	17.89	14.10	17.98	25.76	12.75	21.90	26.00
8.	Diameter of fruit (cm)	3.98	4.56	4.36	4.25	4.17	4.15	4.95	5.20
9.	Thickness of flesh (cm)	1.06	1.13	1.19	1.03	1.08	0.95	1.29	1.43
10.	Core diameter (cm)	1.89	2.30	1.96	2.15	2.11	2.23	2.40	2.48
11.	Yield per vine (kg)	0.82	1.09	1.05	0.74	0.88	0.61	0.83	0.65
12.	Final vine length (cm)	170.90	181.24	154.00	229.95	224.93	99.00	189.40	217.05
13.	PDI (%)	22.27	13.30	15.60	18.22	13.25	25.19	26.29	27.35

The cluster mean for node number of first female flower was maximum in cluster H (11.0) followed by cluster E (9.25), cluster G (9.05), while minimum in cluster F (5.95) followed by cluster B (6.21). The remaining clusters had intermediate mean values.

The cluster mean for days to first harvest was maximum in cluster H (72.20) followed by cluster E (66.57), cluster D (64.40), cluster A (62.37) and cluster G (61.70). It was minimum in cluster F (51.80) followed by cluster C (52.85). The remaining clusters had intermediate values.

The cluster mean value for number of fruits per vine was maximum in cluster C (7.45) followed by cluster B (6.70). It was lowest in cluster H (2.70) followed by cluster G (3.50). The rest of the clusters had intermediate values.

The cluster mean for weight of fruit was maximum in cluster G (237.50) followed by cluster H (235.0), while minimum in cluster F (130.0). The remaining clusters had intermediate mean values.

The cluster mean for length of fruit was maximum in cluster H (26.0) followed by cluster E (25.76) and it was minimum in cluster F (12.75). The rest of the clusters had intermediate values.

The cluster mean for diameter of fruit was highest in cluster H (5.20) followed by cluster G (4.95) and it was lowest in cluster A (3.98). All other remaining clusters had intermediate values.

The cluster mean for thickness of flesh was maximum in cluster H (1.43) and minimum in cluster F (0.95). The rest of the clusters had intermediate values.

The cluster mean for core diameter was highest in cluster H (2.48) followed by cluster G (2.40) and it was lowest in cluster A (1.89) followed by cluster C (1.96). The remaining clusters had intermediate values.

The cluster mean for yield per vine was highest in cluster B (1.09) followed by cluster C (1.05). It was lowest in cluster F (0.61) followed by cluster H (0.65). The rest of the clusters had intermediate values.

The cluster mean for final vine length was maximum in cluster D (229.95) and minimum in cluster F (99.0). All other remaining clusters had intermediate values for this trait.

The cluster mean for per cent disease intensity was highest in cluster H (27.35) and lowest in cluster E (13.25). Rest of the clusters showed intermediate values.

In the present investigation, negligible incidence of pests like Aphids, Fruit fly and Leaf miner were observed.



DISCUSSION

5. DISCUSSION

The results obtained in the present investigation are discussed here under appropriate headings.

5.1 Range of variability

The assessment of available germplasm for its nature and magnitude of genetic variability is an important pre-requisite for developing any variety with high yield potential and the desired morphological and bio-chemical characters. This helps the breeder to assess and identify superior genotypes before initiating the breeding programme for improvement of any crop.

In the present study, among the eighteen cucumber genotypes, a wide range of variability was observed for all the characters.

5.1.1 Characters understudy

The yield of any crop is an important metric trait. Besides inherent genetic potential of genotypes, the yield is also influenced by the environment. In cucumber the number of fruits per vine, weight of fruit, length of fruit, diameter of fruit, thickness of flesh, core diameter are the main yield contributing characters. Wide range of variability for these metric traits was observed in the present investigation. The number of fruits per vine ranged from 2.7 to 7.85, weight of fruit from 127.50 to 237.50 g, length of fruit from 11.47 to 27.75 cm, diameter of fruit from 3.5 to 5.2 cm, thickness of flesh from 0.95 to 1.43 cm and core diameter from 1.36 to 2.47 cm. Significant variability for various characters have been reported by various workers

viz., Naga Prasuna and Rama Rao (1988), Abusaleha and Dutta (1990 a), Rastogi and Arya Deep (1990), Saikia *et al.* (1995), Ram *et al.* (2001) and Tawade (2002).

5.2 Variability parameters

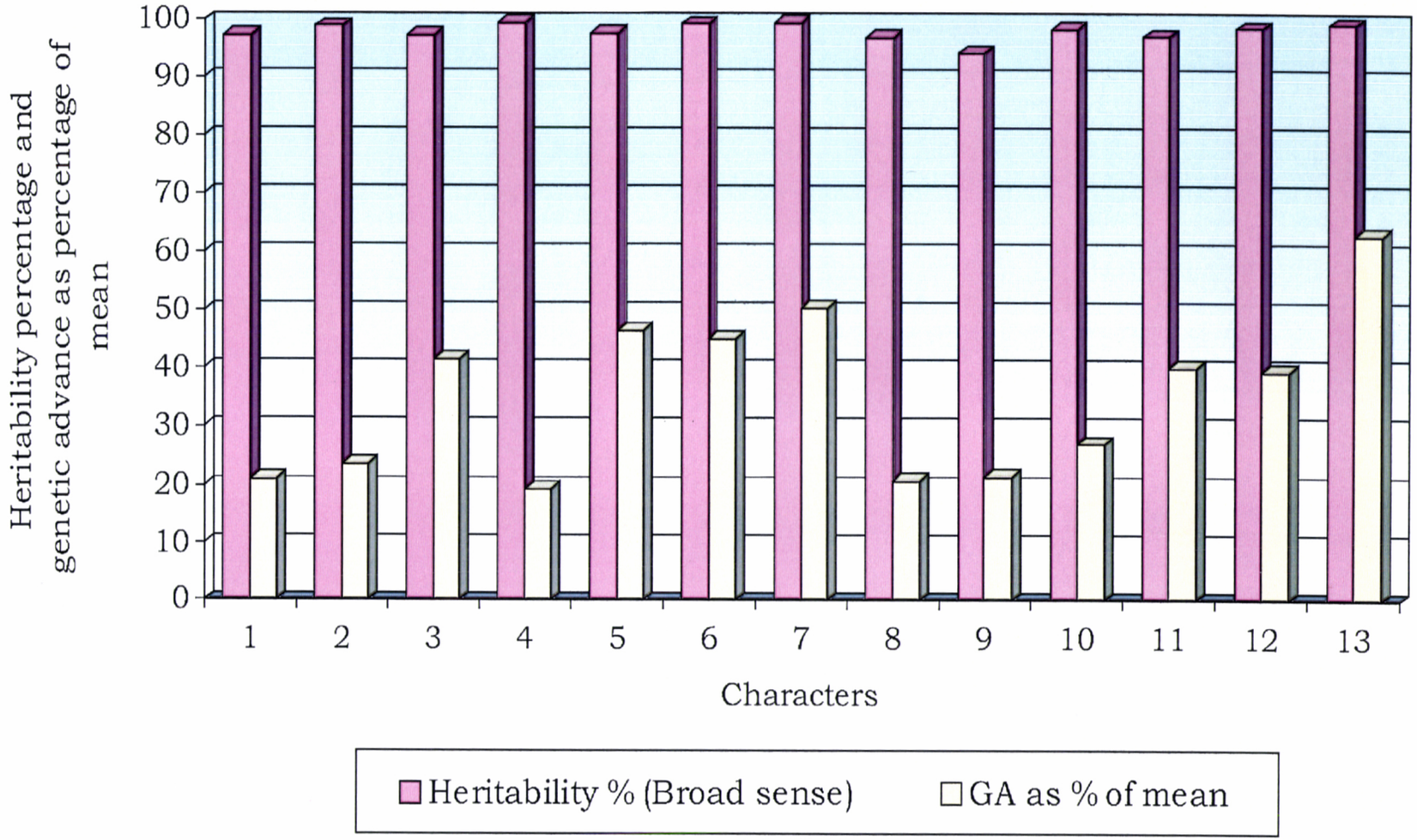
5.2.1 Genotypic and phenotypic coefficients of variation

It is essential to assess the genetic components of variability in the total variation, before the variability can be utilized for further genetic improvement. The additive genetic variance will be the constant heritable portion of the total variation.

Phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all the characters (Table 5) indicating, the substantial modifying effect of environment in the expression of the traits studied. Similar results were reported by Prasad and Singh (1994).

The highest phenotypic and genotypic coefficients of variation were observed for PDI, length of fruit, number of fruits per vine, weight of fruit and node number of first female flower. Joshi *et al.* (1981) also reported high genotypic coefficient of variation for node number with first fruit, number of fruits per plant, fruit yield, fruit circumference and fruit length. Saikia *et al.* (1995) reported high GCV and PCV for yield per plant, fruit weight and number of fruits per plant suggesting the scope for improvement in these characters by selection.

The genotypic and phenotypic coefficients of variation were low for days to first harvest, diameter of fruit, days to appearance of first male flower and thickness of flesh suggesting



1. Days to appearance of first male flower
2. Days to appearance of first female flower
3. Node number of first female flower
4. Days to first harvest
5. Number of fruits per vine
6. weight of fruit (g)
7. Length of fruit (cm)
8. Diameter of fruit (cm)
9. Thickness of flesh (cm)
10. Core diameter (cm)
11. Yield per vine (kg)
12. Final vine length (cm)
13. PDI (%)

Fig.2. Heritability (Broad sense) and genetic advance as percentage of mean

little scope for improvement by selection. These results are confirm with Saikia *et al.* (1995). They observed low PCV for days to first picking. Somkuwar *et al.* (1997) also observed low GCA for days to first harvest.

5.2.2 Heritability and genetic advance

Swarup and Chaugale (1962) suggested that the genotypic coefficient of variation is not sufficient to determine the amount of variation which is heritable.

Burton (1952) concluded that the heritable variation cannot be estimated through genotypic coefficient of variation and as such the genotypic coefficient of variation together with heritability would furnish the most reliable information on the magnitude of genetic advance to be expected from selection.

In the light of this explanation, heritability was calculated to assist the breeder in choosing the characters that can be relied upon for selection (Table 5 and Fig. 2).

The present study revealed that high percentage of heritability in broad sense (above 80) for all the characters viz., days to appearance of first male flower, days to appearance of first female flower, node number of first female flower, days to first harvest, number of fruits per vine, weight of fruit, length of fruit, diameter of fruit, thickness of flesh, core diameter, yield per vine, final vine length and PDI. The observations which shows high heritability suggests the possibility for improvement of these characters through proper selection. Similar results were given by Naga Prasuna and Rama Rao (1988). They reported high heritability for number of female flowers per vine, percentage of

fruit set, number of fruits per vine, fruit volume and average fruit weight, while number of primary branches per vine, days to first female flower appearance and node at which first female flower appeared reported medium heritability estimates. Saikia *et al.* (1995) reported maximum heritability for main vine length, yield per plant and flesh thickness. Ram *et al.* (2001) observed high heritability for fruit length and average fruit weight. Torkadi (2003) observed high estimates of heritability in broad sense for number of fruits per vine, weight of fruits per vine, average weight of fruit, fruit length, fruit diameter, pulp thickness, fruit cavity and PDI in musk melon.

High heritability indicates the effectiveness of selection based on phenotypic performance but does not necessarily mean, a high genetic advance for the particular trait. The characters with high heritability when associated with high genetic gain may be attributed to the additive gene effect (Panse, 1957), which can effectively be improved by selection. On the other hand, high heritability and low genetic advance may be attributed to low phenotypic variability. These characters may be improved through hybridization, while low heritability estimates suggests that the selection for the character under consideration will not be effective.

The genetic advance in the present study ranged from 0.23 for thickness of flesh to 72.44 for final vine length. The genetic advance expressed as percentage of mean ranged from 19.33 for days to first harvest to 62.86 for PDI. High genetic advance for final vine length was reported by Abusaleha and

Dutta (1990 b) in sponge gourd. Prasad and Singh (1994) observed high genetic advance for final vine length, average weight of fruit in cucumber. High genetic advance for weight of fruit, yield per plant, number of female flowers and number of fruits per plant was reported by Rastogi and Arya Deep (1990).

The low genetic advance was observed for characters *viz.,* thickness of flesh, yield per vine, core diameter, diameter of fruit, number of fruits per vine, node number of first female flower, days to appearance of first male flower and length of fruit. Dora *et al.* (2002) reported low genetic advance for diameter of fruit, days to appearance of first female flower, fruit length, fruit set percentage, fruit retention percentage and days taken from fruit set to marketable maturity. Saikia *et al.* (1995) observed low genetic advance for days to anthesis of first male and female flower, number of female flowers per plant, fruit length, fruit girth. Abusaleha and Dutta (1990 a), Prasad and Singh (1990) reported medium genetic advance for number of fruits per vine and fruit length in cucumber and ridge gourd respectively.

In the present study, high estimates of heritability coupled with high genetic advance were obtained for the characters final vine length and weight of fruit. Evidently, the heritability for these characters was due to additive gene effects and is desirable for effective selection in the breeding programme. Prasad and Singh (1994) reported high heritability with high genetic advance for final vine length and fruit weight in cucumber.

High heritability coupled with medium or low genetic advance as exhibited by days to first harvest, PDI, days to appearance of first female flower, length of fruit, days to appearance of first male flower, node number of first female flower, number of fruits per vine, diameter of fruit, core diameter, yield per vine and thickness of fruit, is attributable to the non-additive gene effects. This indicates that hybridization followed by selection will be effective for genetic improvement. Naga Prasuna and Rama Rao (1988) recorded high heritability coupled with low genetic advance for days to female flower in cucumber. Saikia *et al.* (1995) reported high heritability with low genetic advance for days to anthesis of first male and female flower per plant, fruit length, fruit girth and days to first picking. Indiresh (1982) reported heritability with low genetic advance for days to female flower and days to first harvest in bitter gourd. Verghese and Rajan (1993) reported high heritability with low genetic advance for yield per vine, fruit length, days to first harvest and days to first female flower in snake gourd.

5.2.3 Correlation studies

The knowledge of interrelationship among the characters is useful to the breeder for improving the efficiency of selection. The correlation among the various characters are important for three reasons; first, in connection with the changes brought about by selection, which is important to know how the improvement of one character causes simultaneous changes in other characters. Second, in connection with natural selection

and third, in connection with the genetic cause of correlation (Falconer, 1960).

In the present investigation, the estimates of genotypic correlation, in general, were slightly higher than phenotypic correlation showing little masking or modifying effects of the environment on the full expression of the characters under study. However, in general, the genotypic correlations were high for most of the characters indicating that the role of environment was limited in expression of these traits (Table 6). Higher magnitude of genotypic correlation coefficient than the phenotypic correlation coefficient was also observed by Solanki and Seth (1980), Dhaliwal and Randhawa (1998) in cucumber.

The days to appearance of first male flower was positively and significantly correlated with days to appearance of first female flower. Shanthi Priya (2001) found close interrelationship between days to first male flower opening and days to first female flower opening. Tawade (2002) reported significant and positive association for days to staminate flower, pistillate flower and first harvest among each other. The days to appearance of first male flower was negatively and significantly correlated with yield per vine at both genotypic and phenotypic levels. Badade *et al.* (2001a) reported negative significant correlation between yield and days to first male and female flower appearance at both genotypic and phenotypic levels. Abusaleha and Dutta (1998) reported negative correlation between yield and days to opening of male and female flower.

Tawade (2002) reported negative and appreciable association of fruit yield per vine with days to staminate flower.

The days to appearance of first female flower were significantly and positively correlated with node number of first female flower, days to first harvest, length of fruit and final vine length. These results are in confirmed with Dhaliwal and Randhawa (1998) in cucumber. Tawade (2002) reported significant and positive correlation between days to pistillate flower and first harvest. The days to appearance of first female flower were non-significantly and negatively correlated with yield per vine at both genotypic and phenotypic levels. Rao *et al.* (2004) reported non-significant and negative correlation of days to first female flower with yield per plant in cucumber. Prasad and Singh (1994) in cucumber observed negative correlation between yield and days to first flowering, while Mangal *et al.* (1978) reported negative correlation between fruit yield and days to flowering. The number of fruits was negatively correlated with days to first female flower.

The node number of first female flower is non-significantly and negatively correlated with yield per vine. Similar results were reported by Rao *et al.* (2004) in cucumber.

The days to first harvest was significantly but negatively correlated with yield per vine. Similar results were reported by Tawade (2002) and Rao *et al.* (2004) in cucumber and Torkadi (2003) in muskmelon.

The number of fruits per vine showed significant and positive correlation with yield per vine at both genotypic and

phenotypic levels. These results are in conformity with Tawade (2002), Haribabu (1985), Choudhary and Mandal (1987), Abusaleha and Dutta (1988), Naga Prasuna and Rama Rao (1989), Rajput *et al.* (1991), Pandian and Irulappan (1993), Chen *et al.* (1994), Ma *et al.* (1995), Neikov and Alexandrova (1995) in cucumber.

The weight of fruit showed significant and positive correlation with diameter of fruit, thickness of flesh and core diameter at both genotypic and phenotypic levels. Prasad and Singh (1994) reported that the fruit weight was positively correlated with fruit breadth and flesh thickness in cucumber.

The length of fruit showed significant and positive correlation with final vine length at both genotypic and phenotypic levels. Saikia *et al.* (1995), Abusaleha and Dutta (1990 c) observed positive association of yield per vine with vine length, number of branches, number of fruits per vine and fruit length at genotypic and phenotypic levels in cucumber and ridge gourd.

The diameter of fruit showed significant and positive correlation with thickness of flesh and core diameter. Similar results were confirmed by Pandian and Irulappan (1993) in cucumber.

The yield per vine exhibited non-significant but positive correlation with final vine length at both genotypic and phenotypic levels. Haribabu (1985), Choudhary and Mandal (1987) reported non-significant association between yield per plant and vine length.

5.3 Genetic diversity

5.3.1 Diversity based on a set of thirteen characters

The precise information about the extent of divergence is of crucial importance for planning successful breeding programme. More diverse parents within a reasonable range are better for improving the characters under consideration.

The main objective of the present investigation was to know the genetic diversity in a set of eighteen genotypes of cucumber for thirteen characters. The diversities were determined by using Mahalanobis' D^2 statistics. It helps to know the relative distance between the strains for the characters under study.

Adequate diversity between the strains was observed with D^2 values ranging from 294.93 to 15976.42 (Table 7). The minimum D^2 value of 294.93 was observed between genotypes J-04 and Sheetal, while the maximum D^2 value of 15976.42 was observed between the genotypes Improved long green and Poona Khira.

5.3.2 Cluster formation

The aim of forming clusters and finding the intra and inter cluster divergence is to provide the base for selecting parents for making crosses. The theoretical concept in such grouping is that the genotypes grouped into the same cluster presumably vary very little from each other and the crossing between them is not excepted to give desired gene recombinations. Therefore, a breeding programme should be so arranged that the parents selected for crossing should belong to

different clusters. Hence, it is logical in effecting crosses between strains belonging to diverse clusters widely separated by high inter cluster diversity. It is, however, assumed that the statistical distance (D^2) is the index of genetic diversity. It is therefore emphasized that while using this approach, the breeder should not ignore the biological situation.

The maximum inter cluster distance was (Table 10) observed between cluster F and H (D = 11.24) followed by C and H (D = 10.53). This indicated that the genotype Poona Khira from cluster F might had entirely different genetic architectures from the strains included in clusters H and C. The inter cluster divergence was lowest between C and F (D = 5.33) followed by D and E (D = 5.65).

5.3.3 Tentative crossing programme

It is now well established that exploitation of heterosis and success in getting desirable segregants in a breeding programme depends to a great extent on the degree of genetic divergence between the parents chosen (Hayes, 1946; Griffing and Linstorm, 1940). D^2 statistics has added advantage since the estimates are obtained from the study of potential parents themselves and the required information is available before attempting any cross. Therefore, it can be used in choice of parental combinations with the greatest precision.

It is suggested that genotypes from more diverse groups having high yield potential coupled with quality attributes might be useful in a breeding programme. Hence, on similar lines, a crossing programme can be suggested as under.

Cluster A with H, E, F, G

Cluster B with H, E, F

Cluster C with H, E, D, G

Cluster D with F, H

Cluster E with F, G, H

Cluster F with H, G.

The inter cluster values of the above combinations are above 7. Moll *et al.* (1965) suggested that crosses of widely divergent material may have potential utility in yield improvement inspite of poor local adoption of varieties from distant sources. They further added that greater genetic diversity of parents is associated with greater heterosis.

Generally for selecting genetically divergent genotypes (parents), only component characters of yield are taken into account because of their economic importance. Thus, taking into consideration the inter cluster divergence, the character mean of the genotypes and the cluster mean of the genotypes (Table 10 and 11, respectively), a brief breeding programme is suggested below for economically important characters.

1. Days to appearance of first female flower

The lowest cluster mean for this character (39.05) was shown by cluster F followed by cluster C (40.65) and cluster B (44.59). The inter cluster distance observed between F and C (5.33) and F and B (7.71) was sufficient. Therefore, the genotype belonging to these clusters Poona Khira, Himangi, Phule Shubhangi may be tried for early female flowering.

2. Node number of first female flower

The lowest cluster mean for node number of first female flower (5.95) was recorded by cluster F followed by cluster B (6.21) and cluster C (6.50). The inter cluster distance observed between the cluster F and B (7.71) and F and C (5.33) was sufficient. So crosses between the genotypes belonging to these clusters can be suggested. On the basis of mean values for node number of first female flower among the genotypes included in these clusters, the crosses Poona Khira x Poinsette, Poona Khira x Himangi are likely to give superior segregants for node number of first female flower.

3. Days to first harvest

The lowest cluster mean for days to first harvest (51.80) was shown by cluster F followed by cluster C (52.85) and cluster B (56.58). The inter cluster distance between the clusters F and C (5.33) and F and B (7.71) was quite sufficient. Therefore, crosses between genotypes belonging to these clusters i.e. Poona Khira x Himangi, Poona Khira x Phule Shubhangi are likely to give superior recombinations for days to first harvest.

4. Number of fruits per vine

The highest cluster mean for number of fruits per vine recorded by cluster C (7.45) followed by cluster B (6.70) and cluster A (6.17). The inter cluster distance between clusters C and B (6.41) and C and A (6.73) was adequate. So, crosses between genotypes, belonging to these clusters i.e. Himangi x Phule Shubhangi, Himangi x J-02 may be attempted for maximum fruits per vine.

5. Weight of fruit

The highest cluster mean for weight of fruit (237.50) was shown by cluster G followed by cluster H (235.0). The inter cluster distance between cluster G and H (6.99) was quite adequate. Therefore, a cross between genotypes belonging to these clusters i.e. Panvel x Improved long green may gives good results.

6. Length of fruit

The highest cluster mean for length of fruit (26.00) was shown by cluster H followed by cluster E (25.76) with an inter cluster distance 7.11 between them. Hence, the cross Improved long green x KOP-1 may be tried for maximum fruit length.

7. Diameter of fruit

The highest cluster mean for diameter of fruit (5.20) was shown by cluster H followed by cluster G (4.95). The inter cluster distance between the clusters H and G (6.99) was quite sufficient. Therefore, genotypes belonging to these clusters i.e. Improved Long Green x Panvel may be undertaken for maximum fruit diameter.

8. Thickness of flesh

The highest cluster mean for thickness of flesh (1.43) was recorded by cluster H followed by cluster G (1.29). The inter cluster distance between the clusters H and G (6.99) was fairly adequate. So crosses between the genotypes belonging to these clusters i.e. Improved long green x Panvel may be tried for maximum thickness of flesh.

9. Core diameter

The minimum cluster mean for core diameter (1.96) was recorded by cluster C followed by cluster A (1.89). The inter cluster distance between the clusters C and A (6.73) was fairly adequate.

So crosses between the genotypes belonging to these clusters i.e. Himangi x SNG-2 may be attempted for minimum core diameter.

10. Yield per vine

The highest cluster mean for this character (1.09) was shown by the cluster B followed by cluster C (1.05) and E (0.88). The inter cluster distance between B and C (6.41) and B and E (7.77) was quite sufficient. So crosses belonging to these clusters i.e. Phule Shubhangi x Himangi, Phule Shubhangi x KOP-2 may be recommended for maximum yield per vine.

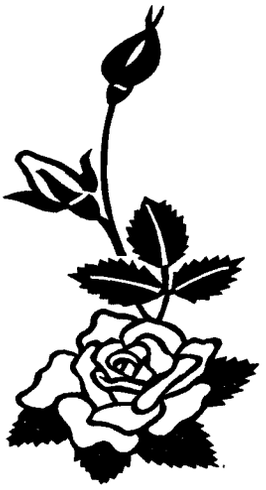
11. Final vine length

The highest cluster mean for final vine length (229.94) was recorded by cluster D followed by cluster E (224.93). The inter cluster distance between the clusters D and E (5.65) was adequate. Therefore the crosses between the genotypes belonging to these clusters i.e. KDWD-1 x KOP-2 may be tried for maximum final vine length.

12. PDI for downy mildew

The minimum cluster mean (13.25) was shown by cluster E followed by cluster B (13.30) with an inter cluster distance of 7.77 between them. So, the cross KOP-1 x Poinsette may be attempted for less incidence of downy mildew.

In general, the information about the genotypes Himangi, Phule Shubhangi, Panvel, Improved long green, J-02, KOP-2, Poona Khira, Poinsette will be helpful in improving yield and yield contributing characters along with earliness and PDI in most of the genotypes. There is a possibility of getting suitable recombinations for high yield along with earliness with less PDI.



SUMMARY AND CONCLUSIONS





6. SUMMARY AND CONCLUSIONS

In the present investigation eighteen genotypes from different parts of the country were obtained from All India Co-ordinated of Research Project on Vegetable, Department of Horticulture, M.P.K.V., Rahuri during the year 2005-2006 to study the nature and extent of variability, direction and magnitude of association among different characters and to measure the divergence between genetic stock of cucumber.

The observations were recorded on the days to appearance of first male and female flower, node number at which first female flower appeared, days to first harvest, number of fruits per vine, weight of fruit, length of fruit, diameter of fruit, thickness of flesh, core diameter, yield per vine, final vine length and PDI for downy mildew.

A wide range of variability was observed for all the characters. The estimates of genotypic coefficients of variation were lower than that of the phenotypic coefficients of variation for all the characters under study. Genotypic as well as phenotypic coefficient of variation were the highest for PDI, length of fruit, number of fruits per vine, weight of fruit and node number of first female flower. Both the components were the lowest for days to first harvest.

High estimates heritability in broad sense were recorded for all the characters i.e. days to appearance of first male and female flower, node number of first female flower, days

to first harvest, number of fruits per vine, weight of fruit, length of fruit, diameter of fruit, thickness of flesh, core diameter, yield per vine, final vine length and PDI.

High heritability value with high genetic advance was obtained for characters like weight of fruit and final vine length. This suggests presence of additive gene effects offering good scope for improvement of these characters by simple selection method.

The estimates of genotypic correlation, in general, were slightly higher than phenotypic correlation indicating little masking or modifying effect of environment on the expression of characters.

The days to appearance of first female flower was positively correlated with node number of first female flower, days to first harvest, length of fruit and final vine length. The node number of first female flower showed significant and positive correlation with days to first harvest, length of fruit and final vine length at both genotypic and phenotypic levels. The number of fruits per vine showed significant and positive correlation with yield per vine. It showed significant but negative correlation with weight of fruit and PDI for downy mildew at both genotypic and phenotypic levels.

The weight of fruit showed significant and positive correlation with diameter of fruit, thickness of flesh and core diameter at both genotypic and phenotypic levels.

The length of fruit showed significant and positive correlation with final vine length, while the diameter of fruit

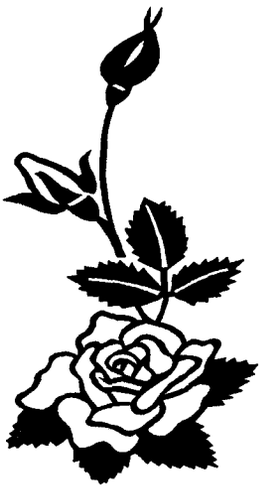
showed significant and positive correlation with thickness of flesh and core diameter at both genotypic and phenotypic levels. The thickness of flesh had significant and positive correlation with core diameter at genotypic level. The core diameter showed non-significant and positive correlation with yield per vine and final vine length. The yield per vine showed significant but negative correlation with PDI for downy mildew, while the final vine length showed non-significant and negative correlation with PDI at both genotypic and phenotypic levels.

The D^2 statistics showed that there was adequate diversity between strains with D^2 values ranging from 294.93 to 15976.42. On the basis of D^2 analysis eighteen genotypes were grouped in eight clusters with substantial genetic divergence between them. The cluster A, B and E had 5, 5 and 3 strains respectively and remaining clusters C, D, F, G and H had only one strain each.

The maximum inter cluster distance was observed between F and H (11.24) and minimum inter cluster distance was recorded between C and F (5.33). The clustering pattern revealed that the genetic diversity was not parallel to the geographical distribution of the genotypes.

Considering the overall performance, a well planned breeding programme has been suggested on the basis of inter cluster divergence and cluster means for the concerned characters.

The crosses involving in the genotypes Himangi, Phule Shubhangi, Panvel, Improved Long Green, J-02, KOP-2, Poona Khira and Poinsette will be useful for improvement of yield and their contributing characters, earliness and PDI for downy mildew. There is possibility of getting suitable recombinant for yield and good quality with tolerance to downy mildew disease.



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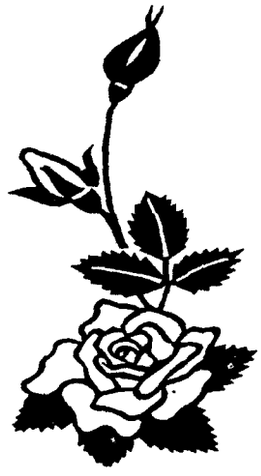
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*** Originals not seen**



VITA

8. VITA

Gaikwad Anita Govind

A candidate for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

in

HORTICULTURE

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