DEVELOPMENT AND EVALUATION OF HYBRIDS IN IVY GOURD (*Coccinia grandis* L.Voigt.)

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CERTIFICATE

Certified that this thesis entitled '**Development and evaluation of hybrids in ivy gourd (*Coccinia grandis* L. Voigt)**' is a record of research work done independently by Mr. R. Prabu (2006-11-113) under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to his.

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DECLARATION

I hereby declare that this thesis entitled '**Development and evaluation of hybrids in ivy gourd (*Coccinia grandis* L. Voigt)**' is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title, of any other university or society.

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23-09-2008.

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Dedicated to
My dear chairman
Dr.D.Wilson, Professor
& his family

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INTRODUCTION

1. INTRODUCTION

Cucurbits are a highly evolutionary group and many of them are known to be vegetables for human consumption from the remote age of civilization. The ancient Indian civilization was basically dependent upon and intimately related with the forests and flora. Sanskrit prose, scriptures, epics, poetical works such as "Vedas", "Upanishads", "Ramayana", "Mahabharata", "Brahmanas", "Puranas" and medical treatises dating back to the ages before Christian era mention several kinds of cucurbits.

India is the home of ivy gourd (*Coccinia grandis* L. Voigt.) having primary gene centre of diversification (Seshadri and More, 2004). Ivy gourd otherwise called gentleman's toes (English), Kovakkai (Malayalam), and Kovaikkai (Tamil) is a common vegetable cultivated in South East Asian countries. It is widely distributed throughout the tropics and found in both wild and cultivated state in the plains of India. There are two distinct types sweet and bitter. Several cultivars of the sweet type are extensively cultivated in different parts of Kerala for its edible fruits.

Ivy gourd is dioecious having male and female plants (Veeraragavathatham et al., 1998). Distinct sex forms in *Coccinia* are due to the presence of characteristically distinct sex chromosomes. Its diploid chromosome number is 2n = 24. Gynodioeceious forms consisting of female and hermaphrodite flowers have also been observed. Maleness is expressed by the influence of 'Y' chromosome. The pericarp in *Coccinia grandis* develops from homogeneous ovary wall. It is distinguished into outer, middle and inner regions. There is an increase in the number of cell layers and cell size with some differentiation of the cells during the development of the fruit from the ovary (Ilyas and Muhammad, 1995).

Tender fruits of ivy gourd contain 1-2 per cent protein (Sachan and Chaundawat, 1985). Being rich in beta-carotene it is a good source of dietary vitamin A (Wasantwisut and Viriyapanich, 2003). It has

considerable amount of protein, fibre, and modest amount of calcium. The tender fruits and shoots of ivy gourd are eaten raw or cooked while roots, stem and leaves are used as ingredients of medicines for the treatment of skin diseases and bronchitis (Veeraragavathatham et al., 1998). Dhanabal et al. (2004) reported that ivy gourd has been widely used in the traditional treatment of *Diabetes mellitus* disease.

Ivy gourd is highly cross pollinated in nature. However, due to the non availability androecious plants, viable seeds are not produced. Even though ivy gourd is a potential vegetable crop for the tropics, crop improvement programmes are scanty. However variety the 'Sulabha' released by Kerala Agricultural University is cultivated in many parts of Kerala. Being a clonally propagated crop there is scope for the development of hybrid clones in ivy gourd. Androecious lines having variations in leaf and floral characters have also been identified from different regions but no reports are available on the development of hybrid clones in ivy gourd.

The success of breeding programme depends on the availability of genetic variation in a population. Information on variability, components of phenotypic and genotypic variation, correlation and path analysis are the basic requirements for crop improvement. The present study was undertaken with the following objectives.

(i) Estimation of genetic variability among the hybrid population.

(ii) Estimation of genetic variability within the hybrid progenies.

(iii) Correlation and path analysis to estimate direct and indirect effects of yield contributing characters on yield.

(iv) Estimation of standard heterosis using the check variety 'Sulabha'.

(v) Identification of superior hybrids over check variety.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Estimation of genetic parameters is the primary requirement to formulate efficient breeding strategy in any crop. Genetic studies in ivy gourd are meager. Attempts on hybridization in this crop have also not yet been reported. In this study attempts were made to develop hybrids and estimate their genetic variation between and within families. Hence variability studies reported in ivy gourd and other cucurbitaceous crop are reviewed in a crop wise manner in this chapter.

2.1. Genetic parameters

2.1.1. Variance and coefficient of variation

The effectiveness of selection in crop improvement programmes depends on the extent of genetic variability present in the population. The variability present in the plant population is of three types viz., phenotypic, genotypic and environmental. Of these the genetic variance can be further partitioned into additive, dominance and epistatic components variance. The genetic parameters such as phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (h^2) and genetic advance (GA) serves as a basis for selection (Johnson et al. 1955).

Ivy gourd

Raju and Peter (1995) reported considerable variability in fruit length, fruit weight and fruit size. Joseph (1999) observed a wide range of variation for days for first flower opening, fruit length, fruit weight, fruits per plant and yield per plant. The PCV and GCV were high for primary branches and fruit yield. Sarnaik et al. (1999) evaluated 35 genotypes of ivy gourd and reported wide range of variation for fruit diameter, number of fruits and yield per plant. Varghese (2003) reported maximum

variability for yield per plant followed by flowers per plant in ivy gourd. Characters viz., days to first flowering, fruit weight, fruit size and vitamin C registered a variability of less than 20 per cent both at genotypic and phenotypic levels.

Suresh (2004) recorded high PCV and GCV for fruits per plant, total number of harvest and yield per plant in ivy gourd. Wilson et al. (2006) recorded high PCV and GCV of 65.58 and 64.17 per cent respectively for yield per plant. The least PCV and GCV were observed for fruit girth.

Cucumber

Rao (1988) reported that in F_1 progenies of cucumber the GCV values ranged from 5.14 to 73.35 per cent while PCV values ranged from 8.52 to 80.13 per cent. Abusaleha and Dutta (1990) studied 75 pure genotypes of cucumber and observed high magnitude of genotypic and phenotypic variance for all the characters studied. Rastogi and Deep (1990) recorded higher PCV and GCV for fruit yield per plant and fruit weight and the lowest for days to fruit maturity in cucumber .

In cucumber, Gayathri (1997) reported highest PCV (95.8 per cent) and GCV (92.9 per cent) for yield per plant and lowest PCV (13.6 per cent) for days to first fruit harvest and lowest GCV (11.2 per cent) for days to first flower opening.

Musk melon

Swamy et al. (1985) performed variability studies in muskmelon and they found highest GCV and PCV for marketable yield per plant followed by total yield per plant and average fruit weight. Chacko (1992) observed moderate to high GCV for yield per plant in a study for evaluation of dessert type musk melon. In culinary melon, Kandaswamy (2004) observed highest PCV and GCV for yield per plant followed by average fruit weight and fruits per plant. Parmar and Tarsen Lal (2005) recorded highest genotypic (91.09 per cent) and phenotypic (93.32 per cent) coefficients of variation for number of fruits per vine. Prasad et al.

(2002) in their studies with 32 inbred lines of musk melon revealed high genetic variation for node at which first male flower appeared and days to first flower opening. Rakhi and Rajamony (2005) conducted genetic studies in land races of culinary melon and found highest PCV and GCV for fruit yield per plant followed by fruit weight, fruits per plant and keeping quality.

Bitter gourd

The highest GCV for yield per plant and the lowest for days to first female flower opening were reported by Mangal et al. (1981) in their studies with 21 varieties of bitter gourd. Suribabu et al. (1986) anlaysed six lines of bitter gourd and found that GCV was moderate to high for all the characters except fruits per plant and percentage of fruit set. Indiresh (1982) studied 24 lines of bitter gourd and observed high GCV for fresh fruit weight, yield per plant and fruit size. While studying the genetic variability among 50 genotypes of bitter gourd, Vahab (1989) observed significant differences for 18 characters. The high PCV were observed for fruit length, yield and fruits per plant, while earliness exhibited low PCV. The GCV was of high magnitude for majority of characters. Jaiswal et al. (1990) found that fruits of various cultivars varied in colour, size, and weight, contents of protein, carbohydrates, vitamin A, vitamin C, acidity and total phenol.

In bitter gourd, Thakur et al. (1994) reported significant variability for vine length, branches per plant, root - shoot ratio and flowers per plant. Study conducted by Rajput et al. (1996) in bitter gourd reported large variations for yield and its components at the phenotypic and genotypic levels. Manju and Wilson (2002) reported the highest phenotypic and genotypic coefficient of variation for fruit yield per plant followed by number of seeds per fruit in their studies using 53 genotypes of diverse origin.

Bhave et al. (2003) reported in bitter gourd that the PCV was higher than the GCV for all the characters studied. The PCV and GCV

were higher for total fruit yield per vine. In a study with 46 genotypes of bitter gourd, Raja et al. (2007) observed that genotypic and phenotypic coefficients of variation for different characters ranged from 6.375 to 37.251 and 8.373 to 38.630 per cent respectively. The highest PCV and GCV were observed for number of female flowers per plant followed by fruit weight.

Bottle gourd

Tyagi (1972) conducted a study in bottle gourd using 25 inbreds and noted that fruits per plant exhibited the highest GCV (48.26 per cent) followed by fruit length and girth. Kumar et al. (1999) noticed maximum GCV for fruits per plant followed by yield per plant. Mathew et al. (1999) in bottle gourd observed significant differences for days to first female flower opening, sex ratio, fruits per plant, fruit yield per plant and fruit size. Bisognin and Storck (2000) reported significant estimates for genetic variance for fruit diameter and neck diameter in bottle gourd. Mathew et al. (2001) evaluated 28 accessions and recorded high coefficients of variation for fruits per plant (32.50 per cent), fruit length (24.8 per cent) and fruit weight (22.40 per cent).

Ridge gourd

High PCV and GCV for fruits per plant, fruit weight and yield per plant were reported by Varalakshmi et al. (1995). In a study in ridge gourd, Anitha (1998) reported high PCV and GCV for number of days to first harvest, fruits per plant, yield per plant, average fruit weight and fruit size. In ridge gourd, Choudhury and Sarma (2002) evaluated 12 cultivars and recorded high phenotypic and genotypic coefficients of variation for fruit weight and yield per hectare. They showed that the phenotypic coefficient of variation was greater than genotypic coefficient of variation for all the characters. Singh et al. (2002) in an experiment with 80 genetically diverse genotypes of ridge gourd observed that PCV and GCV were high for fruits per plant, fruit weight and yield per plant. Karuppaiah and Kavitha (2002) observed GCV values ranging from 13.36 to 33.77 per

cent for different characters. High GCV was observed for number of female flowers per plant, yield per plant, and number of fruits per plant.

Snake gourd

Varghese (1991) and Varghese and Rajan (1993) observed that, the PCV and GCV were the highest for yield per plant, fruits per plant, fruit length, and average fruit weight while days to female flower opening and fruit picking had low estimates of PCV and GCV. Mathew (1999) reported the highest PCV and GCV for mean fruit weight and the lowest PCV and GCV for flesh thickness. Radhika (1999) found that in snake gourd the PCV values ranged from 5.63 to 21.63 per cent. PCV for yield per plant was the highest followed by fruits per plant. Ashok (2000) found wide variation in seed growth and yield characters in a study of character association of seeds with plant morphology in snake gourd. The GCV was high for fruit yield, number of fruits per plant and fruit length in snake gourd (Rahman et al., 2002).

Watermelon

Variability pattern of 48 water melon inbred lines were studied by Prasad et al. (2002) and observed high PCV values of number of fruits, node at which female flower appeared and days to female flower opening,.

Ash gourd

George (1981) conducted biochemical studies in ash gourd and reported significant differences for protein content and vitamin C in fruits, fruit yield, fruit weight, fruits per plant and fruit size and the variability was low for days to first female flower anthesis. Lovely and Radhadevi (2007) noted in ash gourd high PCV and GCV for mean fruit weight, fruit yield per plant and fruits per plant which indicates high genetic variability. They also reported comparatively low coefficient of variation for days to first female flower.

Pumpkin

Mohanty and Mishra (1999) observed high GCV and PCV for yield and fruits per plant in pumpkin and PCV was greater than GCV for all the traits. Sirohi and Yayasani (2001) revealed variation in the total soluble solids and carotenoid content of eight genetically diverse lines and varieties and their F_1 hybrids of pumpkin. Lakshmi et al. (2002) recorded high PCV GCV for days to first female flowering in pumpkin.

2.1.2. Heritability and genetic advance

Heritability and genetic advance are important selection parameters. The ratio of genotypic variance to the phenotypic variance is known as heritability. The difference between the mean phenotypic value of the progeny of selected plants and the base or parental population is called genetic advance (GA). High heritability means that the character is least influenced by environment. High genetic advance shows that the character is governed by additive genes and low genetic advance shows the existence of non additive gene action.

Ivy gourd

In ivy gourd, Joseph (1999) observed high heritability for vine length, primary branches per plant, fruit field per plant and fruits per vine. Varghese (2003) recorded high heritability and genetic advance for all the characters studied, except number of days for first flower opening which exhibited high heritability and low genetic advance in ivy gourd.

Suresh (2004) observed high heritability along with high GA for all the characters in ivy gourd. The range of heritability was 98.83 to 63.02. While studying the genetic variability of 61 clones of ivy gourd, Wilson et al. (2006) observed the highest heritability for days to first harvest (99.62 per cent) followed by days to first flowering (99.19 per cent). Expected genetic advance as percentage of mean was the maximum for days to first harvest (36.23 per cent) and the lowest was recorded for fruit girth (0.92 per cent).

Cucumber

Choudhary et al. (1985) reported significant genotypic variance for several yield components in cucumber. Yield per vine and fruits per vine had high GA along with high heritability. High heritability and low GA has been reported for days to first female flower appearance and fruit length. Prasunna and Rao (1988) reported high heritability for fruits per vine and average fruit weight in cucumber.

Mariappan and Pappiah (1990) in their studies on 45 diverse genotypes of cucumber reported high heritability along with high GA for fruit girth. Study with 23 genotypes of cucumber by Prasad and Singh (1992) revealed that the heritability estimates ranged from 0.02 per cent for fruits per plant to 48 per cent for fruit length. High heritability coupled with high GA was observed for fruit length, fruit breadth and fruit weight. High heritability and high GA for more than 12 growth and yield attributes were also observed in cucumber (Prasad ad Singh 1994).

Wehner and Cramer (1996) reported low to moderate heritability for fruit yield, earliness and quality. Paiva and Paiva (1997) derived information on variation and heritability from 36 half sib progenies in cucumber and reported that heritability was the lowest for fruit number and highest for number of fruits. Gayathri (1997) reported that yield per plant, fruits per plant, average fruit weight and node to first female flower had the highest GCV with high heritability and genetic advance. Kanwar et al. (2003) evaluated 26 genotypes of cucumber and observed high heritability estimates associated with high genetic gain for sex ratio, yield per plant and node of first female flower.

Bitter gourd

Vahab (1989) observed high heritability coupled with high genetic gain for fruit weight, yield and fruits per plant in bitter gourd. Choudhary et al. (1991) also reported high estimates of heritability and genetic advance for yield per plant and fruits per plant. Rajput et al. (1995) reported high heritability in bitter gourd for almost all the yield and

related characters such as fruits per plant, fruit weight and fruit size. Iswaraprasad (2000) recorded high heritability for days to first female flower, days to first fruit harvest, fruits per plant, mean weight of fruit and fruit yield per plant in a study using seven parents and 21 hybrids of bitter gourd.

Manju and Wilson (2002) observed high heritability for 100 seed weight, weight of fruits, days to first male flower anthesis and fruit length. They also found maximum genetic advance for number of seeds per fruit followed by weight of fruit, fruit length and yield. All characters excluding days to first fruit harvest showed high estimates of genetic advance. In bitter gourd, Raja et al. (2007) reported high heritability coupled with greater GA for fruit weight and yield per plot.

Ridge gourd

In ridge gourd, Varalakshmi et al. (1995) observed high heritability values for fruit weight, days to first female flower, fruit length and fruits per plant and low heritability for fruit diameter. Anitha (1998) has reported high heritability along with high genetic advance for fruits per plant, yield per plant and days to first female flower opening. Days to first harvest had high heritability but low genetic advance.

High heritability and high GA were recorded for fruit weight and yield per hectare by Choudhury and Sarma (2002) in 12 cultivars of ridge gourd. Singh et al. (2002) in a study with 80 genotypes of ridge gourd found high heritability coupled with high genetic advance for appearance of first male and female flower, fruits per plant, fruit length, fruit weight and yield per plant. Julie Mole et al. (2002) estimated genetic parameters in 53 accessions of ridge gourd and reported high heritability along with high genetic gain for vine length, sex ratio, number of fruits per plant, length of fruit and seeds per fruit. Days to first female flowering and days to first harvest though had high heritability values, showed only low genetic gain. The number fruits per plant had the highest positive and significant correlation with yield. Karuppaiah and Kavitha (2002)

observed high heritability for days to first female flowering, number of male flowers per plant, yield per plant, number of female flowers per plant, and flesh thickness. High heritability along with high genetic advance was observed for number of female flowers per plant yield per plant, number of fruits per plant and flesh thickness.

Snake gourd

Varghese (1991) in snake gourd observed high heritability coupled with high genetic gains for flowers per plant. Varghese and Rajan (1993) noticed high magnitude of heritability and GA for fruits per plant, while yield per plant, fruit length and days to first harvest showed high heritability coupled with low genetic gain. Mathew and Khader (1999) reported that mean fruit weight, fruit length and fruit yield per plant had high heritability coupled with high GA.

In snake gourd, Radhika (1999) reported the highest and the lowest values of heritability for days to first female flower and vine length respectively. High heritability along with high genetic advance was noticed for days to first female flower opening, fruit yield per plant and fruits per plant. High to moderate heritability as well as genetic advance was observed for fruit yield, number of fruits per plant, fruit length and average fruit weight in snake gourd (Rahman et al., 2002).

Bottle gourd

In bottle gourd, Kumar et al. (1999) observed high heritability for all the character studied and high genetic advance was recorded for fruit yield per plant followed by number of fruits per plant and number of branches per plant. Mathew (1999) reported high heritability and genetic advance for fruit length and fruit girth.

Pointed gourd

Sarkar et al. (1990) reported high heritability and low GA for fruit diameter in pointed gourd. Singh et al. (1992) reported high heritability for all the characters studied. High heritability with high GA was observed for yield and fruits per plant.

Pumpkin

In pumpkin, Mohanty and Mishra (1999) reported moderate heritability with high GA for yield per plant. Days to first anthesis showed moderate to high heritability accompanied by low genetic advance. Bindu et al. (2000) recorded high heritability and high GA for fruit length, fruit weight, fruits per plant and yield per hectare through the evaluation of 24 genotypes of pumpkin. In the study of 19 pumpkin genotypes, Mohanty (2000) observed high heritability and high GA as per cent of mean for the characters fruit weight, fruits per plant and yield per plant and high heritability alone for days to anthesis of first female flower.

Melon

Chacko (1992) evaluated desert type of musk melon and reported high heritability with high GA for yield per vine. Deepthy (2000) observed high heritability and genetic advance for yield per plant, mean fruit weight, and fruits per plant in melon. Parmar and Tarsem Lal (2005) found that heritability estimates in the broad sense were very high (>75 per cent) for all the characters except node at which the first female flower opens. Number of fruits per vine showed the highest genetic advance. High heritability along with high GA as percentage of mean was observed for number of fruits per vine. High heritability coupled with high genetic advance was reported by Rakhi and Rajamony (2005) for fruit length and fruit weight in land races of culinary melon. Zalapa et al. (2006) reported that narrow sense heritability was 0.62 for days to anthesis, 0.70 for fruit weight per plant and 0.79 for average weight per fruit in melon.

Ash gourd

Lovely and Radhadevi (2007) observed that fruits per plant, mean fruit weight, fruit yield per plant, fruit length and fruit girth had high heritability coupled with high GA indicating additive gene action.

Water melon

Prasad et al. (2002) and observed high heritability coupled with high genetic advance for number of fruits, node number, vine length, and yield per plot.

2.2 Correlation Analysis

Selection is the basis for crop improvement in order to increase yield. Several other component characters contributing towards yield make it the subject of a distinct study. Correlation studies would facilitate effective selection for improvement of one or many yield contributing components. Study of relationship of yield with other traits is of immense help in any crop improvement programme.

Ivy gourd

In ivy gourd, Joseph (1999) reported that fruits per plant, average fruit weight, fruit girth and fruit length showed significant positive correlation with yield. Highest correlation with yield was recorded for fruits per plant. Yield per plant showed positive and significant correlation with fruits per plant and size of fruits at genotypic and phenotypic levels in ivy gourd (Sarnaik et al. 1999).

Varghese (2003) reported that in ivy gourd yield per plant exhibited positive association with all the characters except number of days for flowering, which had significant negative correlation with yield. Suresh (2004) observed that all characters except days to first flowering are correlated with yield both at phenotype and genotypic levels. Average fruit weight and fruits per plant had positive direct effect on yield.

Cucumber

Rastogi and Deep (1990) in a study with 25 genotypes of cucumber revealed positive correlation of yield per plant with fruits per plant, fruit weight and fruit size. Positive correlation of yield with vine length, branches per vine, number of flowers per vine and total fruits per vine and negative correlation with days to flower and percentage of deshaped fruits

were recorded by Satyanarayana (1991). Chen et al. (1994) found that there was significant positive genotypic correlation between number of flowers, number of parthenocarpic fruits and yield.

Ma et al. (1995) reported that total yield had a significant positive correlation with total fruit number, fruit size and average fruit weight in cucumber. Damarany et al. (1995) observed a negative relationship between total yield and number of days for first flowering. The total yield had significant positive correlation with total fruit number.

Fruits per plant, average fruit weight, fruit size and fruit diameter were highly correlated with yield in cucumber (Gayathri, 1997). Zhang et al. (1999) reported that the three traits with largest direct positive action on early yield were average fruit weight, harvested fruits per plant and average fruit length in cucumber. Correlations analysis indicated that yield was positively correlated with fruit weight and fruit length both at genotypic and phenotypic levels (Rao et al., 2004).

Bitter gourd

In bitter gourd, Lawande and Patil (1989) reported that yield per plant was positively correlated with fruit weight and fruits per plant. In correlation and path analysis of 21 genotypes of bitter gourd they indicated that fruit yield per vine was positively correlated with fruits per vine, average fruit weight and fruit length. Fruit yield per vine was negatively correlated with days to first flower opening both at genotypic and phenotypic levels. Bhave et al. (2003) observed that fruit number per vine was highly correlated with total fruit yield per vine.

Snake gourd

Pynadath (1978) reported that yield per plant was highly correlated with days to first female flower, fruit weight and fruit girth. Fruit weight, fruit girth and number of fruits were the characters contributing to yield in snake gourd. Ashok (2000) noted strong correlation between yield and fruit characters and fruits per plant in snake gourd.

Water melon

In water melon, Shibukumar (1995) observed that yield per plant recorded high positive genotypic and phenotypic correlations with fruits per plant, weight of individual fruit and fruit size. Negative correlation was seen for yield per plant with days to first flower opening. Prasad et al. (2002) revealed that number of fruits per plant had significantly high positive correlation with yield per plot and significant negative association was noticed with days to first male and female flower opening. Saroj Rolania et al. (2003) reported that magnitude of genotypic correlation co-efficient was generally higher than that of phenotypic correlation coefficient. Fruit yield was positively correlated with main vine length, number of primary branches per plant, number of nodes per plant, number of female flowers per plant, number of fruit per plant and harvest duration.

Pointed gourd

In pointed gourd, Prasad and Singh (1990) reported positive association of yield with fruit number and negative correlation with days to first flowering and picking. Singh et al. (1993) reported that yield was positively correlated with number of fruits per plant in pointed gourd. Fruits per plant, days to first flowering and average fruit weight were responsible for yield increase. Sarkar et al. (1999) conducted correlation studies in pointed gourd and reported that fruit weight and fruit size was positively and significantly correlated with yield per plant at genotypic and phenotypic levels.

Ridge gourd

Anitha (1998) reported that days to first female flower, days to first harvest, fruits per plant and average fruit weight had significant positive correlation with yield in ridge gourd. Rao et al. (2000) observed that in ridge gourd yield per vine was significantly and positively associated with fruits girth and fruits per vine. Negative association was observed for days

to first female flower. Julie Mole et al. (2002) in their studies using 53 accessions of ridge gourd observed that the number fruits per plant had the highest positive and significant correlation with yield. Karuppaiah and Kavitha (2002) observed significant and positive correlation of yield with single fruit weight, fruit length, fruit girth, number of fruits per plant, fruit size index, flesh thickness, number of male and female flowers per plant, days to first male flowering and days to harvest.

2.3. Path coefficient analysis

Path analysis is an extension of multiple regressions. It goes beyond regression in that it allows for the analysis of more complicated models. In particular, it can examine situations in which there are several final dependent variables and those in which there are "chains" of influence, in that variable A influences variable B, which in turn affects variable C. Despite its previous name of "causal modelling," path analysis cannot be used to establish causality or even to determine whether a specific model is correct; it can only determine whether the data are consistent with the model. However, it is extremely powerful for examining complex models and for comparing different models to determine which one best fits the data.

Ivy gourd

In ivy gourd Varghese (2003) reported almost all characters showed positive direct effect on fruit yield per plant except days to first flowering which showed negative direct effect.

Cucumber

In cucumber, Prasunna and Rao (1988) reported that fruits per vine and average fruit weight were the important yield contributing characters. Fruits per vine and yield were showed significant positive correlation. Rajput et al. (1991) reported that harvest period also influenced yield but its degree of association was reduced with increasing vine length. Prasad and Singh (1992) in the path analysis of yield in 23 genotypes of

cucumber revealed positive direct effect of vine length, days to female flower appearance, fruit weight and fruit length on yield.

Path analysis of eight genotypes of cucumber revealed that fruits per plant had maximum direct positive effect on yield followed by fruit weight (Saika et al. 1995). Gayathri (1997) reported that fruit size exerted maximum direct positive effect on yield followed by average fruit weight and fruits per plant in cucumber. Rao et al. (2004) revealed that characters such as fruit weight and numbers of fruits per plant are highly dependable and reliable for selection to improve yield.

Pumpkin

In pumpkin, Kumaran et al. (1998) reported that fruits per plant exhibited the highest direct effect on yield. High positive indirect effect was exerted by fruits per plant and mean fruit weight.

Bitter gourd

In bitter gourd, Paranjape and Rajput (1995) found that yield was mainly contributed by fruits per vine and fruit weight. The fruit weight had maximum direct effect on yield and fruits per vine indirectly contributed towards yield. Bhave et al. (2003) reported fruit length and average fruit weight had the highest positive direct effects, followed by harvesting span, fruit length and number of fruits per vine.

Ridge gourd

In ridge gourd, Rao et al (2000) reported that fruits per vine and weight of fruit had high direct effect of yield. Karuppaiah and Kavitha (2002) observed that the number of fruits per plant, number of female flowers per plant, flesh thickness, number of male flowers per plant, days to female flower opening exerted maximum positive direct effect on yield in addition to their positive indirect effect through other characters.

Ash gourd

Menon (1998) found that in ash gourd average fruit weight exhibited highest positive direct effect on fruit yield followed by number of fruits.

Watermelon

Shibukumar (1995) reported that in watermelon, fruit yield was directly affected by days to flower followed by fruits per vine and fruit weight.

Musk melon

Dhaliwal et al. (1996) reported that in musk melon, fruit yield was directly related by days to first flowering followed by fruit per vine and fruit weight. Lal and Singh (1997) observed that fruits per vine and fruit weight had direct effect on yield.

2.4. Standard heterosis

The term heterosis was coined by Shull in 1914. It refers to the superiority of F_1 hybrids over its parents. In other words, heterosis refers to increase of F_1 in fitness and vigour over the parental values. While heterosis refers to the phenomenon (cause), hybrid vigour is the phenotypic expression (effect) of the genetical phenomenon. In current usuage, heterosis and hybrid vigour are used as synonyms and interchangeable.

Existence of significant amount of dominance variance is essential for undertaking heterosis breeding programme. Dominance effects are associated with heterozygosity. Therefore, in plant populations, dominance effects are expected to the maximum in cross pollinated crops (Frey, 1966). For this reason, occurrence of heterosis has been reported for most of the traits. The available literature on heterosis in cucurbits is presented in a crop wise manner.

Cucumber

Imam et al. (1977) reported that heterosis ranged from 15 .34 per cent for fruit diameter to 59.22 per cent for fruit shape index in cucumber. Pyzhenkov and Kosareva (1979) made hybrids between four male and four female parents in cucumber and reported that heterosis for yield was

reflected as increased number of fruits per plant. The mean fruit weight of the hybrids was not more than parents.

Kasem and Somsak (1991) evaluated the hybrid performance of crosses among 21 mini- cucumber lines and reported significant heterosis for characters like flowering habits yield and fruit characters like fruit length, fruit width and average fruit weight.

Fang et al. (1994) developed a hybrid 'Zhongnong 8' from a cross between 90271 and line 90211 which was heterotic over standard variety for total yield per vine and average fruit weight in cucumber. Significant positive heterosis for total yield, fruit number and average weight were reported in cucumber by Li et al. (1995). Gayathri (1997) reported all the three types of heterosis for days to first female flower opening in cucumber. Wilson and Deepthy (2006) studied heterosis for fruit characters in melon and found significant standard heterosis for number of fruits in seven hybrids and six hybrids exhibited significant standard heterosis for yield per plant.

Susheel Sharma et al. (2007) reported maximum heterobeltiosis of 39.57 per cent in the hybrid AAUC –1 x K. Paprola and the minimum heterobeltiosis was observed in the hybrid Sel. 75-1-10 x K. Paprola for marketable yield per plant when Pusa Sanyog was used as a standard check.

Bitter gourd

Lawande and Patil (1990) reported that heterosis for yield per vine was 86.1 per cent in bitter gourd. Ranpise et al. (1992) derived information on heterosis from diallel analysis of eight lines and 28 F_1 hybrids in bitter gourd and reported 64 per cent heterosis for yield in the most promising hybrid.

Mishra et al. (1994) indicated a high level of heterosis for fruits per plant, fruit length, weight and yield in bitter gourd after performing a diallel analysis using nine varieties. Kenndy et al. (1995) reported that a heterosis of 65.7 per cent over standard parent. Ram et al. (1997)

observed negative heterosis for days to female flower anthesis. Fruits per plant and yield per plant were the most heterotic characters.

Bottle gourd

Janakiram and Sirohi (1992) in their studies on heterosis in round fruited bottle gourd revealed that the best performing hybrid S 46 x S 54 gave 148.97 per cent higher yield over the commercial cultivar Pusa Summer Prolific Round and 84.5 per cent over best parental line. Sharma et al. (1995) gathered information on heterosis in bottle gourd from a line x tester cross and observerd that, the cross Summer Long Green Selection 2 x Faizabadi Long had the largest heterosis over control cultivar Pusa Summer Prolific Long for number of fruits (106.63 per cent) and total yield per plant (110.33 per cent). Another cross showed 22.93 per cent heterosis for fruit length. Dubey and Maurya (2002) reported heterosis over the three best parents ranging from 89.76 to 121.35 per cent over the mid parent, 68.44 to 91.02 percent over the better parent and 80.94 to 89.47 per cent over the check variety for fruit yield per plant. Significant heterobeltiosis and standard heterosis for fruit yield per plant, total soluble sugars, fruits per plant and fruit weight were recorded by Bhalala et al. (2002) evaluated 45 crosses in bottle gourd and found 74.4 per cent heterobeltiosis and 74.5 per cent standard heterosis for fruit yield per plant. High magnitude heterosis for total soluble sugars, fruits per plant and fruit weight also reported in their study.

Pumpkin and Squashes

Sirohi (1993) noticed appreciable heterosis for important quantitative characters including yield in pumpkin. The F_1 'Pusa Hybrid 1' showed significant heterosis for yield over the commercial check Pusa Vishwas. According to Ghai et al. (1998) F_1 hybrids in summer squash showed significant heterosis for yield. Pandey et al. (2002) evaluated 12 F_1 hybrids of pumpkin and reported 82 per cent heterosis for number of fruits per plant, 44.84 per cent for average fruit weight and 27.33 per cent for length of fruits.

Snake gourd

Varghese and Rajan (1993 b) studied heterosis for growth characters in snake gourd and found standard heterosis for days to first fruit picking maturity. Radhika (1999) reported that manifestation of heterosis for all the characters studied. Among the hybrids Thrikkannapuram Local x Kaumudi had maximum standard heterosis (73.28 per cent) for yield and yield related characters.

Ash gourd

Mandal and Sirohi (2002) reported heterosis for early maturity, longer vine, more number of fruits per plant, bigger fruit size and higher fruit weight in ash gourd.

Water melon

Reddy et al. (1987) evaluated six watermelon cultivars with their 15 F_1 hybrids in a diallel analysis and reported that hybrids showed significant heterosis for yield per plant, number of fruits per plant and average fruit weight.

Musk melon

Choudhary et al. (2002) reported heterobeltiosis for fruit yield per plant in three crosses viz.,MS_1 x Hara Madhu, Jobner Local x Durgapura Madhu and Jobner Local x Hara Madhu.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

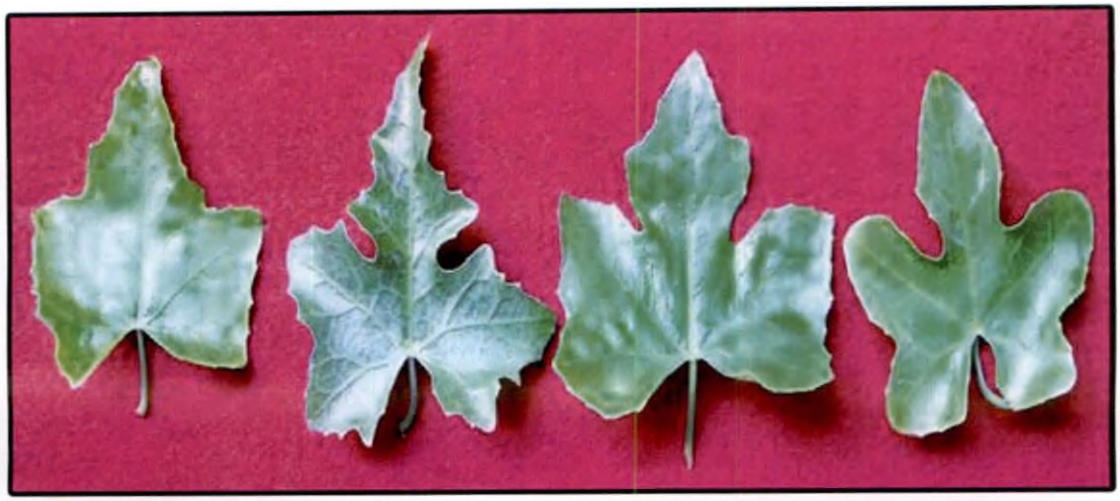
The present study was carried out at the Department of Plant Breeding and Genetics, College of Agriculture, Vellayani during 2007-2008 as two experiments with a view to develop and evaluate hybrids in ivy gourd. The details of materials used and methods adopted for the study are presented below.

Ivy gourd is propagated by vegetative method. Clonal variation exists among the clones grown in different regions. Being a dioecious crop, conventional biometric analysis is not possible in this crop. However hybrid seeds can be produced through heterosis breeding. The estimation of variation between and with in the hybrid progenies facilitates selection of superior hybrids.

3.1 Materials

The experimental material comprised of four gynoecious lines of ivy gourd (*Coccinia grandis* L Voigt.) namely Royappanpatty 1 (F.P-1), NBPGR-9 (F.P-2), Kannur-6 (F.P-3), and Karuvalur (F.P-4) and three androecious lines namely Royappanpatty local (M.P-1), Vellayani local (M.P-2) and Karyavattom (M.P-3). The fruit characters of the female parents and the floral and leaf characters are presented in Plate 1. The leaf and flower characters of the male parents are presented in Plate 2. The selected parents were crossed with each other to produce twelve hybrid combinations.

Morphological Characters of the Female Parents



FP 1 FP 2 FP 3 FP 4

FP 1 FP 2 FP 3 FP 4

FP 1 FP 2 FP 3 FP 4

Plate 1

Morphological Characters of the Male Parents

MP 1

MP 2

MP 3

MP 1

MP 2

MP 3

Plate 2

Hybridization Technique

Plate 3

Table 1 Female and male parents used for the experiments

Crosses	Combinations	Parentage
F_1	FP1 x MP1	Royappanpatty 1 x Royappanpatty local
F_2	FP1 x MP2	Royappanpatty 1 x Vellayani local
F_3	FP1 x MP3	Royappanpatty 1 x Karyavattam
F_4	FP2 x MP1	NBPGR-9 x Royappanpatty local
F_5	FP2 x MP2	NBPGR-9 x Vellayani local
F_6	FP2 x MP3	NBPGR-9 x x Karyavattam
F_7	FP3 x MP1	Kannur-6 x Royappanpatty local
F_8	FP3 x MP2	Kannur-6 x Vellayani local
F_9	FP3 x MP3	Kannur-6 x Karyavattam
F_{10}	FP4 x MP1	Karuvalur x Royappanpatty local
F_{11}	FP4 x MP2	Karuvalur x Vellayani local
F_{12}	FP4 x MP3	Karuvalur x x Karyavattam

3.1.1 Experiment I: Production of F_1 seeds

The parents for hybridization were raised in the field. Staggered planting was done to facilitate synchronous flowering to ensure successful production of hybrids in all combinations.

Four female parents and three male parents were crossed in all possible combinations to get hybrid seeds. Mature male and female flower buds in the parental lines were kept covered with a cover on the previous day of anthesis. On the following day, hand pollination was done between 8.30 am to 10 am (Plate 3) and pollinated female flowers were kept covered and labeled. The covers kept over female flowers were removed after two or three days. The ripe fruits were harvested for collecting seeds. The seeds were dried in shade and stored for raising F_1 progeny.

Field View

Plate 4

3.1.2. Experiment II: Evaluation of F_1 hybrids

The hybrid seeds obtained from 12 cross combinations were raised in the field for evaluation (Plate 4)

3.2 Design and Layout

The experiment was laid out in Compact Family Block Design (CFBD) with three replications at spacing of 3 x 3 m. Each hybrid progeny consists of seven plants. The male progenies were removed from the experimental field.

3.2.1 Cultural practices

The seeds of twelve crosses were sown in pots separately to raise seedlings for planting in the main experimental field.

The experimental field was prepared and pits were taken at a spacing of 3 x 3 m. FYM @ 25 kg/pit was given in two split doses. Twenty five days old hybrid seedlings were used for planting. Three seedlings were planted per each pit but after the establishment of seedlings only two seedlings were retained. Pandals were raised for trailing. Basal application of fertilizers at the rate of NPK 28:10:10 g per pit was given followed by top dressing at three weeks interval. Regular irrigation was given during dry periods. Need based application of insecticides was done to protect the crop from insect pests.

3.2.2. Biometric observations

Biometric observations were taken from seven plants in each treatment adopting standard procedures and average was worked out for each replication.

3.2.2.1 Days to first flowering

Number of days taken from sowing to anthesis of first female flower in each plant was recorded.

3.2.2.2 Days to first harvest

Number of days taken from sowing to first harvest in each plant was recorded.

3.2.2.3 Fruit length (cm)

The length of five fruits taken at random from each plant was measured and the average worked out.

3.2.2.4 *Fruit girth (cm)*

The girth of five fruits taken at random from each plant was measured and the average worked out.

3.2.2.5 Fruit weight (g)

The weight of five randomly selected fruits from each plant was taken and the average worked out to obtain the mean fruit weight in grams.

3.2.2.6 Number of fruits per plant

The number of fruits obtained from each plant in fifteen harvests was recorded separately and the total was worked out to record the number of fruits per plant.

3.2.2.7 Vitamin C

Vitamin C content in tender fruits was estimated using volumetric method and expressed as mg/100 g (Sadasivam and Manickam,1996).

3.2.2.8 Fruit yield per plant

The weight of fruits obtained from each plant in fifteen harvests was recorded separately in grams and the total was worked out to record the fruit yield per plant.

3.2.2.9 Morphological appearance

Colour and pigmentation of fruits in each progeny were recorded.

3.2.2.10 Incidence of pests and diseases

Incidence of pests or diseases were observed and recorded.

3.3 Statistical Analysis

The data collected were subjected to statistical analysis.

3.3.1 Analysis of variance

Analysis of variance was carried out for all the traits to find out whether there is any difference among the families.

Analysis of variance for families

Source	df	SS	MS	F
Replication	r-1	SSR	MSR	
Families	f-1	SSF	MSF	
Error	(r-1) (f-1)	SSE	MSE	

Analysis of variance for progenies within the family

Source	df	SS	MS	F
Replication	r-1	SSR	MSR	
Progenies	p-1	SSP	MSP	
Error	(r-1) (p-1)	SSE	MSE	

Pooled analysis of variance

Source	df	SS	MS	F
Replication	r-1	SSR	MSR	
Families	f-1	SSF	MSF	
Error	(r-1) (f-1)	SSE	MSE	
Progeny in F_1	(p-1)	SSP	MSP	
F_2	(p-1)	SSP	MSP	
F_3	(p-1)	SSP	MSP	
F_4	(p-1)	SSP	MSP	
F_5	(p-1)	SSP	MSP	
F_6	(p-1)	SSP	MSP	
F_7	(p-1)	SSP	MSP	
F_8	(p-1)	SSP	MSP	
F_9	(p-1)	SSP	MSP	
F_{10}	(p-1)	SSP	MSP	
F_{11}	(p-1)	SSP	MSP	
F_{12}	(p-1)	SSP	MSP	
Pooled error	F(r-1)(p-1)	SSE	MSE	

Where, r = Number of replication, f = Number of treatments

P = Number of progenies, SSR = Replication sum of square

MSR = Replication mean square SSF = Family sum of square

MSF = Family mean square

When the treatments differed significantly by the F test, the pair wise comparison of the treatment means are made by using critical difference as

Critical difference (CD) = $t_{(\infty)}\sqrt{\frac{2MSE}{r}}$

Where, t ∞ is the students't' table value for ∞ (5 per cent or 1 per cent) level of significance corresponding to the error degree of freedom.

3.3.2 Components of variance

Based on the initial analysis homogeneous group of progenies within each family were identified. These groups of progenies within the family were used for the estimation of genetic components. The mean squares between treatments consisted of variances attributable to genotype, environment and phenotype (Singh and Chaudhary, 1985).

For each character the phenotypic and genotypic components of variance were estimated by equating the expected value of mean squares (MS) to the respective variance components (Jain, 1982). Based on this the following variance components were estimated.

i) Genotypic variance, $\sigma^2 g = \frac{MST - MSE}{r}$

ii) Environmental variance, $\sigma^2 e = MSE$

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

3.3.3 Coefficient of variation

It is a unit of measurement used for comparison of variation of different characters measured in different units. Genotypic and phenotypic coefficients of variation were worked out using the estimate of $\sigma^2 g$ and $\sigma^2 p$ and expressed in percentage (Burton, 1952) for each trait.

i) Phenotypic coefficient of variation (PCV)

$$= \frac{\sigma p}{\text{Mean}} \times 100$$

ii) Genotypic coefficient of variation (GCV)

$$= \frac{\sigma g}{\text{Mean}} \times 100$$

3.3.4 Heritability

For each trait heritability (broad sense) was estimated as the ratio of genotypic variance to phenotypic variance and expressed as percentage (Jain, 1982).

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

Heritability per cent was categorized as suggested by Johnson et al. (1955) *viz.*, low (0 – 30), moderate (30 – 60) and high (above 60).

3.3.5 Genetic Advance (Johnson et al. 1955 and Allard 1960)

Genetic advance which measures the change in mean genotypic level of the population brought about by selection depends upon standardised selection differential, heritability and phenotypic standard deviation (Allard, 1960).

Genetic advance as percentage of mean was estimated as per the method suggested by Lush (1940) and Johnson et al. (1955) for each trait as

$$\text{Genetic advance, GA} = \frac{k\, H^2 \sigma p}{\overline{X}} \times 100$$

Where, k is the standardised selection differential (k = 2.06) at five per cent selection intensity and $\overline{X}$ is the mean of the character over all accessions. Genetic advance was categorized into low (below 10 per cent), moderate (10-20 per cent) and high (above 20 per cent) as suggested by Johnson et al. (1955).

3.3.6 Correlation Analysis

Phenotypic, genotypic and environmental correlation coefficients were worked out for two characters X_i and X_j as

$$\text{Genotypic correlation } (r_{g_{ij}}) = \frac{\sigma g_{ij}}{\sigma g_i \times \sigma g_j}$$

$$\text{Phenotypic correlation } (r_{p_{ij}}) = \frac{\sigma p_{ij}}{\sigma p_i \times \sigma p_j}$$

$$\text{Environmental correlation } (r_{e_{ij}}) = \frac{\sigma e_{ij}}{\sigma e_i \times \sigma e_j}$$

where, σg_{ij}, σp_{ij} and σe_{ij} denote the genotypic, phenotypic and error covariances between two traits X_i and X_j respectively.

3.3.7 Path coefficient analysis

Path analysis is applied to identify relatively important component characters (which are the independent 'v' variables) as a dependent variable on the basis of their direct and indirect effects and it helps the plant breeder to lay emphasis on component characters during selection. The solution of the matrix equation

$$A\,\underline{B} = \underline{C}$$

Where A is the genotypic inter-correlation matrix with respect to independent variables, B is the column vector of genotypic correlation co efficient between the dependent and independent variables. Vector $\underline{B}$ provides estimates of path coefficient which means the direct effect of the independent variable on dependent variable, and also the indirect effect of each independent variable on dependent variable through other variables. Residual variation which could arise from unknown and uncontrollable factor was also estimated using vector $\underline{B}$ (Dabholkar, 1992).

The direct and indirect effects were calculated and classified into very high (> 1), high (0.30 – 0.99), moderate (0.20 – 0.29), low (0.10 – 0.19) and negligible (0.00 – 0.09) (Lenka and Mishra, 1973)

3.3.8 Standard heterosis

Heterosis can be estimated in three different ways.

i) As the percentage deviation of the mean performance of F_1's *from its mid parent* which is referred as relative / average heterosis (RH)

ii) As the percentage deviation of the mean performance of F_1's from better parent which is referred as heterobeltiosis (HB)

iii) As the percentage deviation of mean performance of F_1's from a standard parent which is referred as standard heterosis (SH).

Since ivy gourd is a dioecious crop average heterosis and heterobeltiosis cannot be estimated. The standard heterosis was estimated using "Sulabha" as the standard parent.

$$SH = \frac{\overline{F_1} - \overline{SP}}{\overline{SP}} \times 100$$

To test the significance of $\overline{F_1} - \overline{SP}$ observed in standard heterosis Critical Difference is worked out as

$$CD\ (0.05) = t_\alpha \sqrt{\frac{2MSE}{r}}$$

Where, t_α = t value for error degrees of freedom at 5 per cent level of significance

MSE = Error mean square

r = Number of replications.

RESULTS

4. RESULTS

The results of the study entitled "Development and evaluation of hybrids in ivy gourd (*Coccinia grandis* L.Voigt.)" are presented below.

4.1 Production of hybrids in ivy gourd

The hybrid seeds were produced successfully between four gynoecious and three androeicous lines of ivy gourd. The best time of hand pollination for maximum seed set was found to be between 8.30 and 10 am. There was no dormancy and hybrid seeds recorded more than eighty per cent germination in all the crosses.

4.1.1 Evaluation of hybrids

The twelve F_1 families and each family consisting of seven progenies were evaluated in the field for 10 biometric and quality characters namely days to first flowering, days to first harvest, average fruit length (cm), average fruit girth (cm), average fruit weight (g), number of fruits per plant, vitamin C, fruit yield per plant (g), morphological appearance and incidence of pests and diseases.

4.1.1.1 Variability among the families

The analysis of variance conducted for different characters are presented in Table 2. The results showed significant difference for all the characters among the different families.

4.1.1.2 Mean Performance of the families

The mean performances of 12 F_1 families for eight biometric characters studied are given in Table 3.

4.1.1.2.1 Days to first flowering

Days to first flowering showed significant differences among the families. The mean values for this character ranged from 49.62 to 87.99 days. The F_1 (49.62 days) took the minimum number of days to first flowering, which was on par with F_3 (50.58 days). Other families were

significantly different from these two families for days to flowering. The F_{12} (87.99 days) took the maximum days to first flowering.

4.1.1.2.2 Days to first harvest

There was no significant difference among the families for days to first harvest. The mean values for this character ranged from 66.16 to 101.28 days. The F_1 took the minimum days to first harvest (66.16 days) followed by F_9 (74.86 days). The F_{12} took maximum days (101.28 days) to first harvest.

4.1.1.2.3 Average fruit length (cm)

Average fruit length showed significant differences among the families. Fruit length ranged from 4.87 to 8.34 cm. The maximum average fruit length was recorded in the F_1 (8.34 cm) followed by F_3 (8.14 cm) and the minimum fruit length was recorded in the family F_4 (4.87 cm) followed by F_8 (5.58 cm).

4.1.1.2.4 Average fruit girth (cm)

Fruit girth showed significant difference among the families. The mean values for this character ranged from 5.74 to 7.20 cm. The family F_1 showed maximum fruit girth (7.20 cm). The lowest fruit girth was observed in F_4 (5.74 cm).

4.1.1.2.5 Average fruit weight (g)

Fruit weight showed significant differences among the families. Fruit weight ranged from 7.44 to 20.93 g. The family F_1 showed maximum average fruit weight (20.93g) whereas the F_4 showed the least average fruit weight (7.44g).

4.1.1.2.6 Number of fruits per plant

Number of fruits per plant showed significant differences among the families and ranged from 219.95 to 501.52. The maximum number of fruits per plant was observed in the family F_1 (501.52) followed by F_2 (467.27). The minimum number of fruits per plant was observed in the family F_{12} (219.95) which was on par with the families F_6 (240.27), F_5 (258.09) and F_7 (263.79).

Table 2 Mean square values of eight characters in 12 families of ivy gourd

Sources	df	Days to first flowering	Days to first harvest	Average fruit length (cm)	Average fruit girth (cm)	Average fruit weight (g)	Number of fruits per plant	Vitamin C mg/100g	Fruit yield per plant (g)
Replication	2	994.938	736.545	1.776	0.219	6.957	5470.506	5.823	1467737.000
Families	11	2777.048	1951.730	17.908	4.644	271.489	149892.200	57.856	72131390.000
Error	22	192.549	50.195	0.891	0.302	8.990	7587.567	9.009	1605516.000
Progeny in F_1	6	7.603	1.714	0.084	0.043	3.710	6216.000	2.039	871537.800
F_2	6	6.635	9.857	0.153	0.149	3.124	2844.389	1.749	585048.900
F_3	6	10.968	9.539	4.250	0.109	21.102	7358.180	9.177	4012089.000
F_4	6	4.873	16.158	0.744	0.418	3.660	2590.222	15.577	398612.000
F_5	6	29.539	57.650	0.054	0.291	6.850	675.181	15.704	1054546.000
F_6	6	18.762	4.190	0.391	0.506	12.788	1498.215	7.203	443637.300
F_7	6	19.762	19.858	0.297	0.167	4.595	622.708	12.705	419166.200
F_8	6	3.159	9.190	0.099	0.462	1.893	800.660	6.341	447713.800
F_9	6	1.080	7.270	0.597	0.368	5.888	1106.181	4.408	361464.900
F_{10}	6	2.873	2.096	0.153	0.153	4.734	808.319	0.772	601484.400
F_{11}	6	18.158	7.207	0.586	0.497	16.827	8247.111	3.297	214000.000
F_{12}	6	13.763	1.430	0.355	0.265	1.123	221.934	1.779	48050.670
Pooled Error	144	9.320	9.741	0.581	0.268	7.730	3166.442	5.663	1215664.000

Table 3 Mean values of eight characters in twelve F_1 families of ivy gourd.

Families	Days to first flowering	Days to first harvest	Average fruit length (cm)	Average fruit girth (cm)	Average fruit weight (g)	Number of fruits per plant	Vitamin C Content (mg/100g)	Fruit yield per plant (g)
1	49.62	66.16	8.34	7.20	20.93	501.52	20.95	8309.33
2	59.68	76.69	7.08	6.96	16.74	467.27	16.32	7137.96
3	50.58	77.40	8.14	6.86	20.07	422.54	19.43	8058.61
4	65.91	80.70	4.87	5.74	7.44	293.06	20.66	2175.44
5	68.85	77.79	6.70	6.99	14.75	258.09	18.45	4253.63
6	64.87	78.04	6.81	6.76	14.94	240.27	21.12	3476.52
7	69.82	84.43	6.15	6.46	13.02	263.79	20.88	3623.49
8	73.17	83.56	5.58	6.61	12.29	301.51	20.84	3920.12
9	67.76	74.86	6.13	6.10	13.10	298.98	17.73	3764.50
10	73.90	90.42	6.90	5.85	12.65	382.83	18.02	4714.59
11	84.00	96.64	6.78	6.59	16.61	316.93	18.93	3705.52
12	87.99	101.28	6.30	6.03	10.55	219.95	16.82	3148.57
Sulabha	48.40	64.80	7.86	6.43	17.82	356.75	17.93	6031.90
CD @ 5 %	8.80	NS	0.68	0.33	2.44	65.34	2.01	1015.22

4.1.1.2.7 Vitamin C (mg/100g)

The vitamin C content of fruits varied significantly among the families. The mean values for this character ranged from 16.32 to 21.12 mg/100g of sample. The maximum vitamin C content was observed in the family F_6 (21.12 mg/100g). The minimum vitamin C content was recorded in the family F_2 (16.32 mg/100g) which was on par with the families F_{12} (16.82 mg/100g), F_9 (17.73 mg/100g) and F_{10} (18.02 mg/100g).

4.1.1.2.8 Fruit yield per plant (g)

Fruit yield per plant showed significant differences among the families. The mean values for this character ranged from 2175.44 to 8309.33 g. The family F_1 showed maximum fruit yield per plant (8309.33 g) followed by F_3 (8058.61 g). The family F_4 showed the least fruit yield per plant (2175.44 g) which was on par with the family F_{12} (3148.57 g).

4.1.1.2.9 Morphological appearance of fruits

There was a lot of variation for the morphological appearance of fruits. The variations were evident in the colour and shape of fruits and presence or absence of prominent streaks and patches. (Plate 5-10)

4.1.1.2.10 Incidence of pests and diseases.

There was no incidence of major pests and diseases in the experimental plots during the course of study. However irrespective of genotypes minor incidence of fruit fly attack was noticed.

4.1.2 Mean performance of the progenies within families

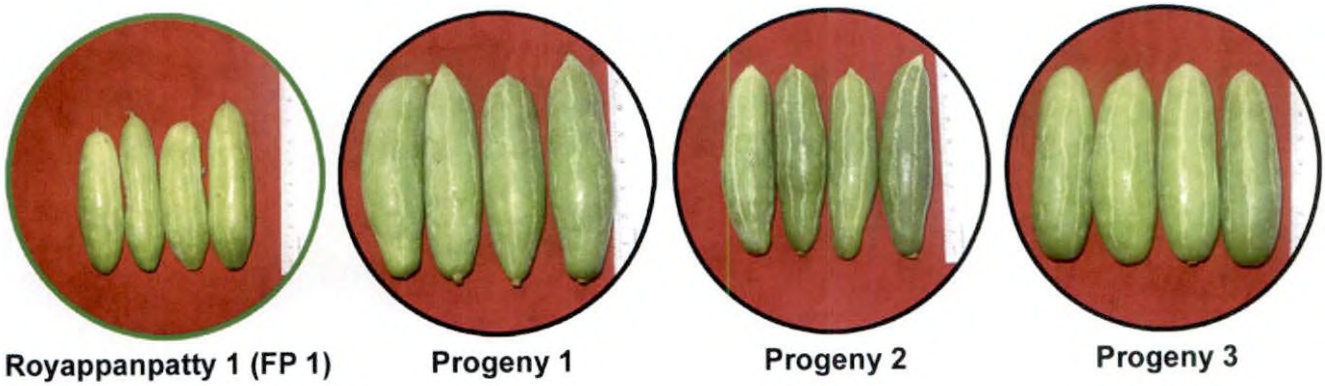
The mean performance of the progenies in 12 families for different characters is presented in Table 4 and Plate 5 – 10.

Family 1

There were no significant differences among the progenies for different characters studied. The mean values for days to first flowering ranged from 48.00 to 52.33 days, days to first harvest from 65.00 to 67.33 days, average fruit length from 7.92 to 8.42 cm, average fruit girth from 7.00 to 7.30 cm, average fruit weight from 18.83 to 21.83 g, number of

Variations in fruit characters among hybrid progenies

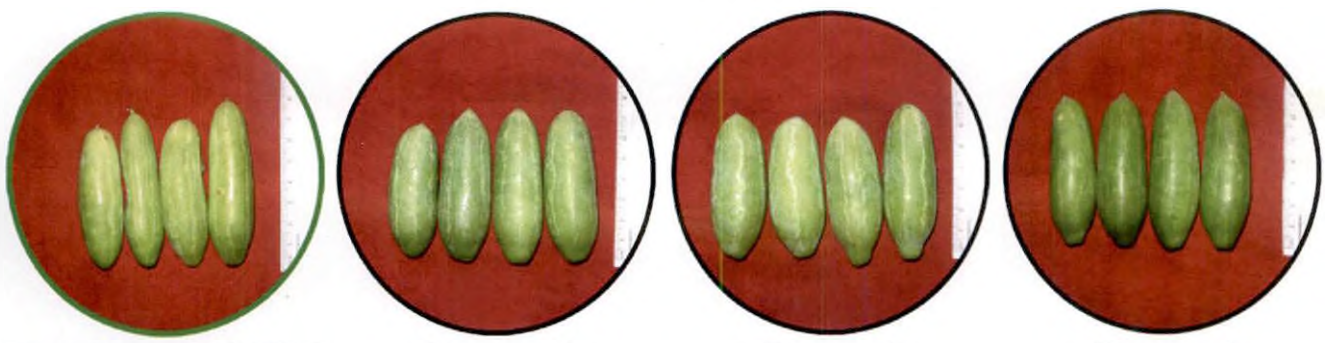
Hybrid 1 (FP 1 X MP 1)



Royappanpatty 1 (FP 1) | Progeny 1 | Progeny 2 | Progeny 3

Progeny 4 | Progeny 5 | Progeny 6 | Progeny 7

Hybrid 2 (FP 1 X MP 2)



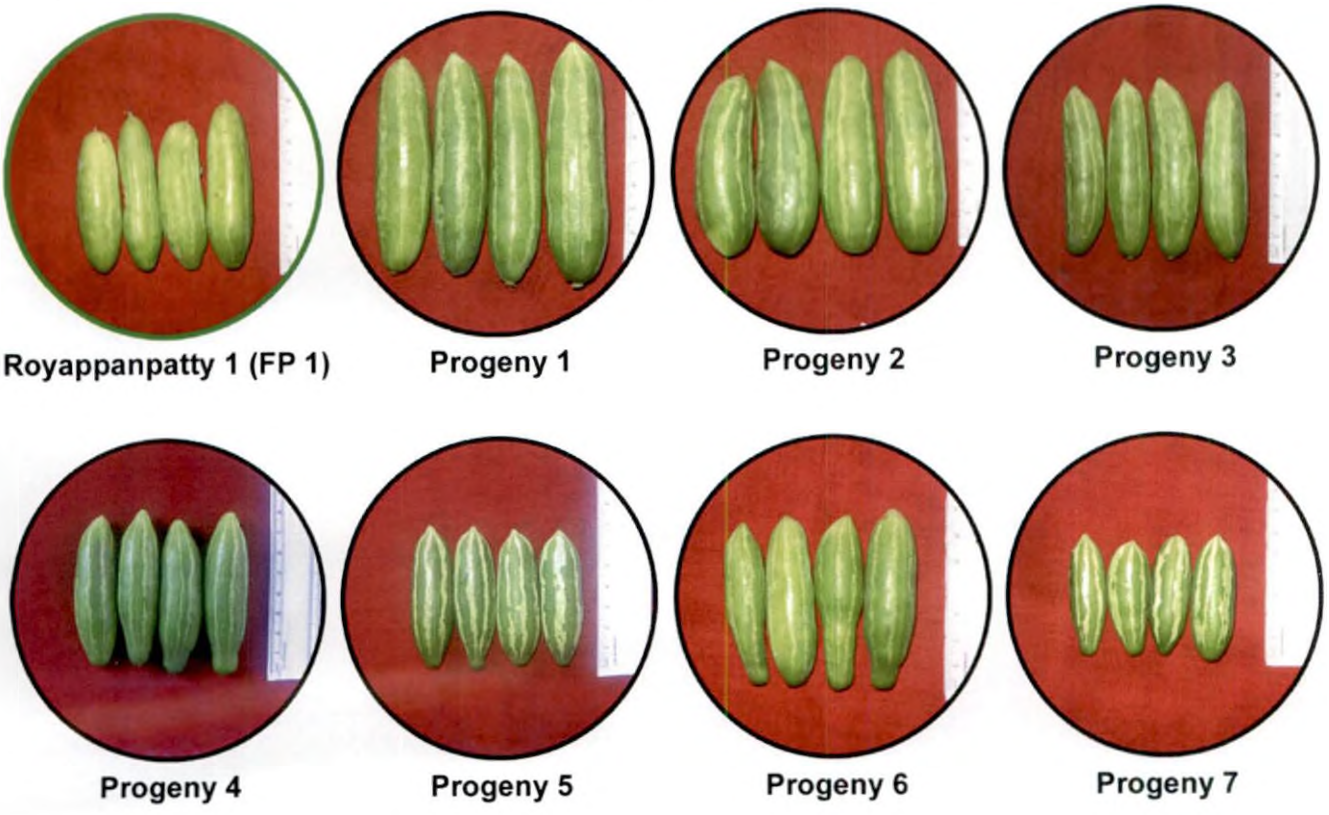
Royappanpatty 1 (FP 1) | Progeny 1 | Progeny 2 | Progeny 3

Progeny 4 | Progeny 5 | Progeny 6 | Progeny 7

Plate 5

Variations in fruit characters among hybrid progenies

Hybrid 3 (FP 1 X MP 3)



Hybrid 4 (FP 2 X MP 1)

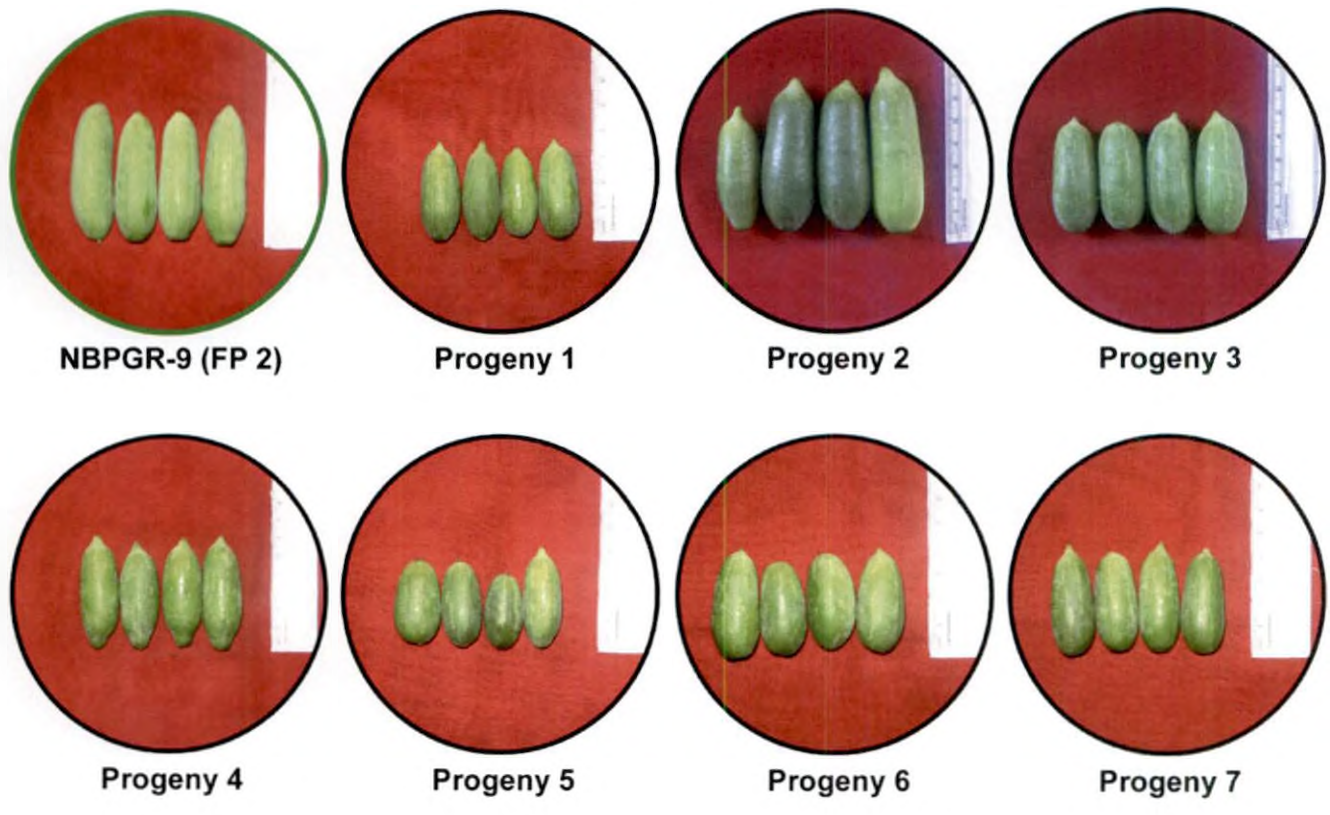
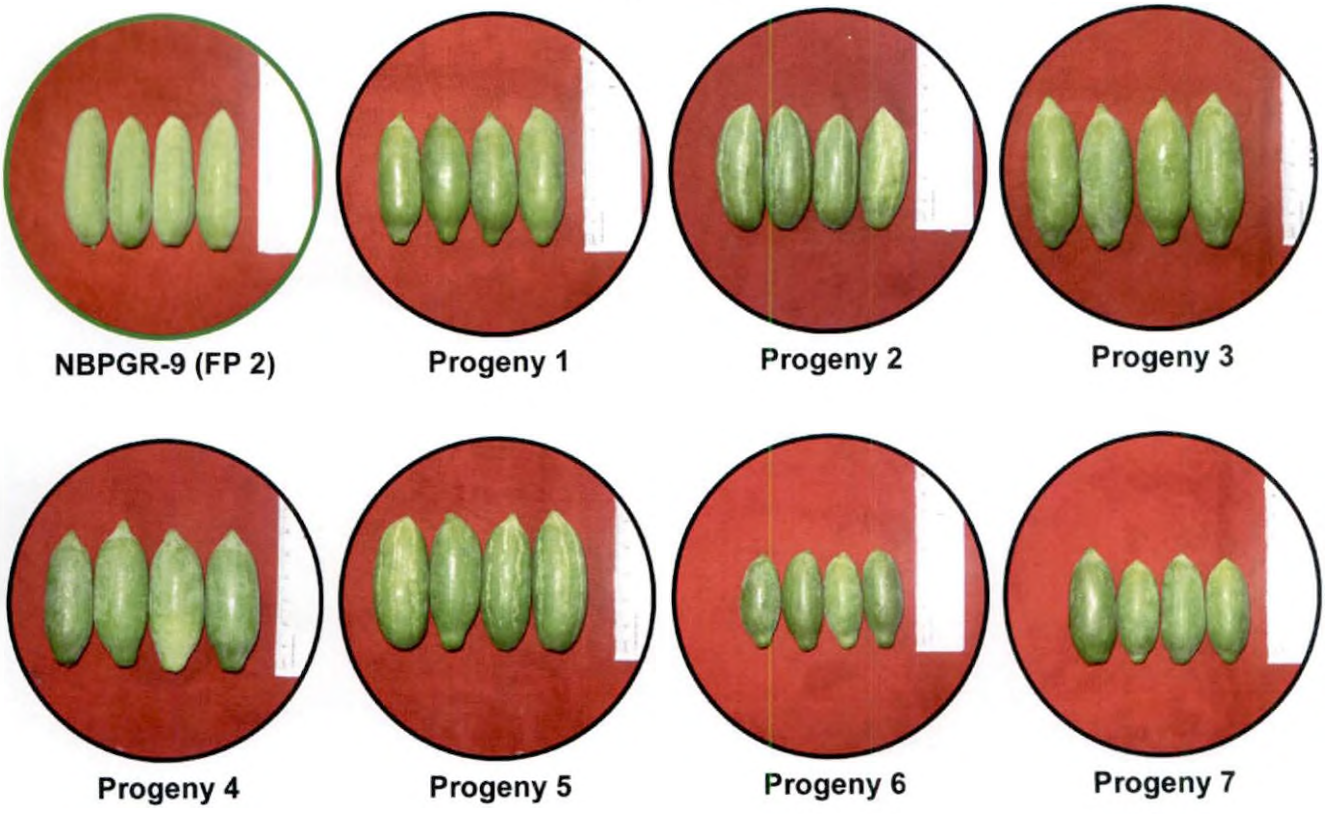


Plate 6

Variations in fruit characters among hybrid progenies

Hybrid 5 (FP 2 X MP 2)



Hybrid 6 (FP 2 X MP 3)

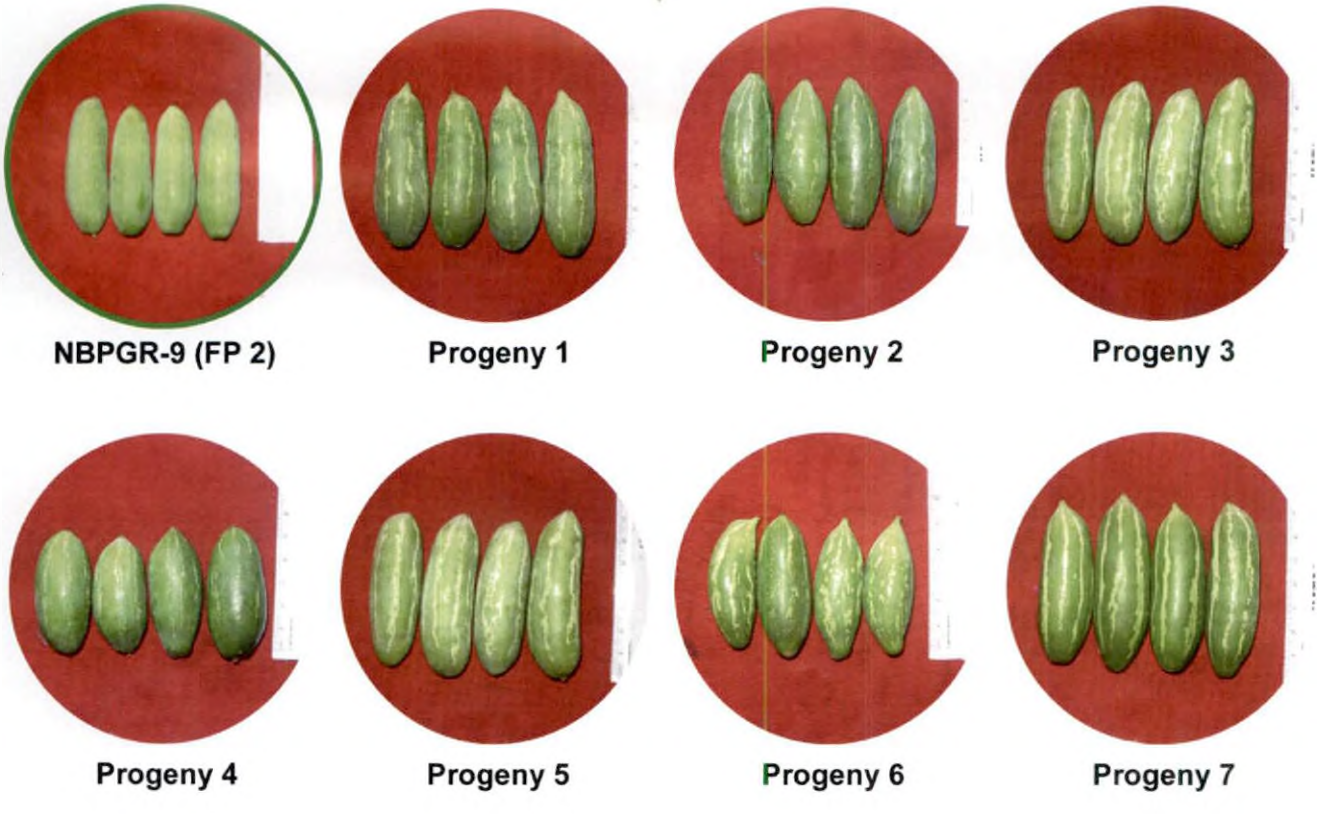
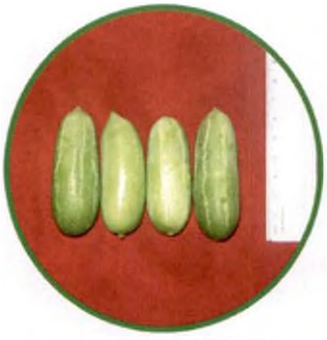


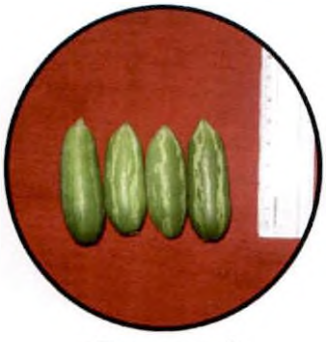
Plate 7

Variations in fruit characters among hybrid progenies

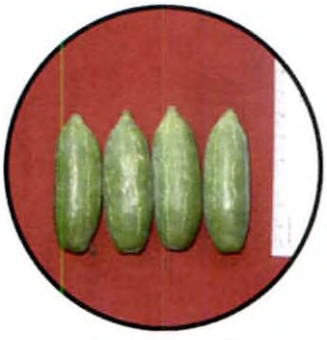
Hybrid 7 (FP 3 X MP 1)



Kannur 6 (FP 3)

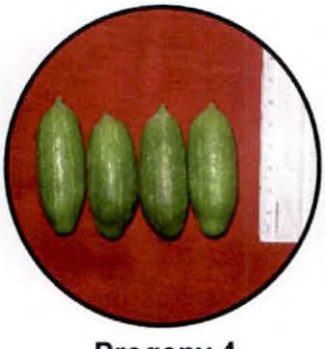


Progeny 1

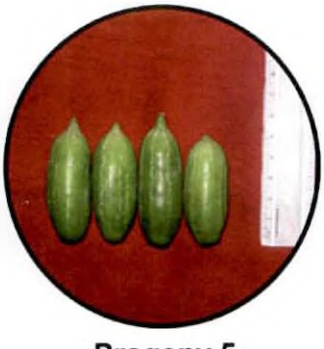


Progeny 2

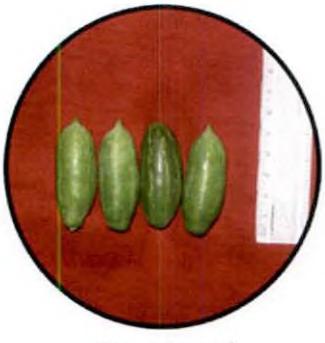
Progeny 3



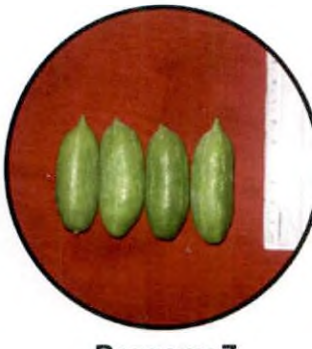
Progeny 4



Progeny 5

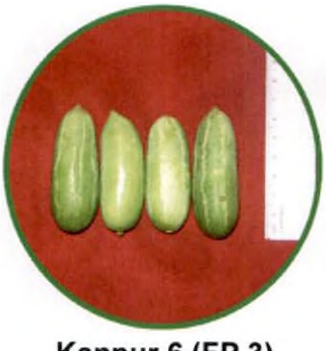


Progeny 6

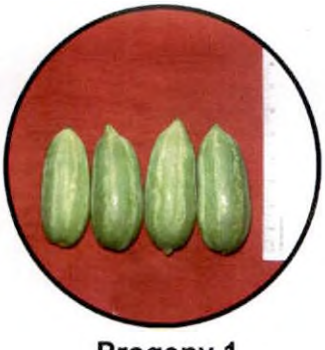


Progeny 7

Hybrid 8 (FP 3 X MP 2)

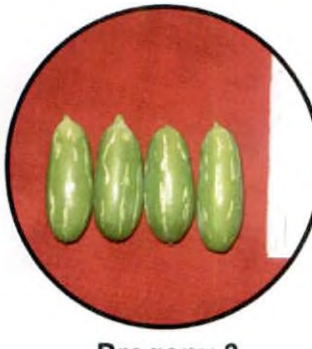


Kannur 6 (FP 3)

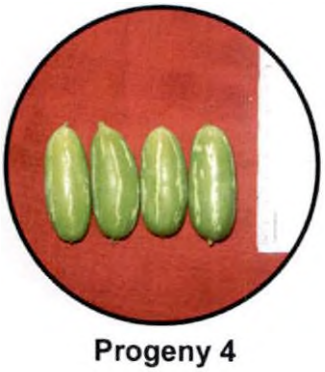


Progeny 1

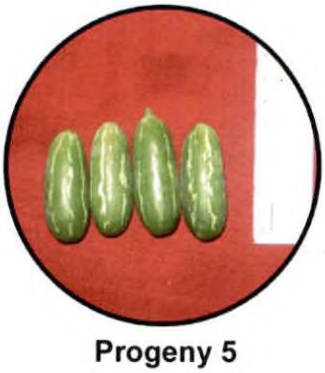
Progeny 2



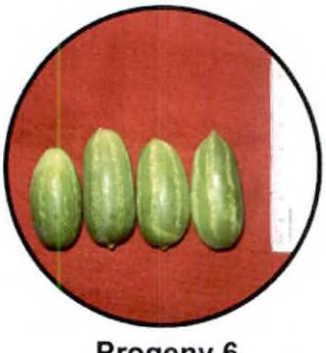
Progeny 3



Progeny 4



Progeny 5



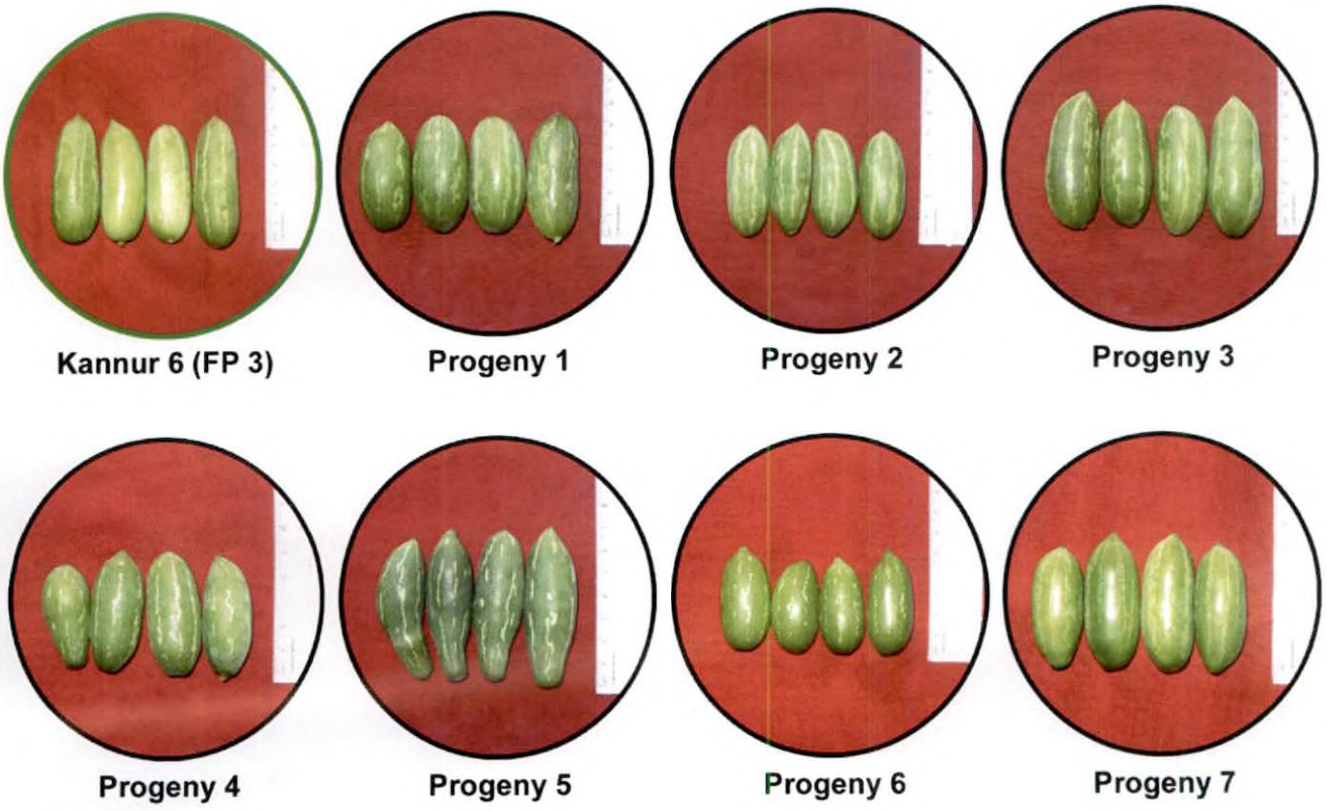
Progeny 6

Progeny 7

Plate 8

Variations in fruit characters among hybrid progenies

Hybrid 9 (FP 3 X MP 3)



Hybrid 10 (FP 4 X MP 1)

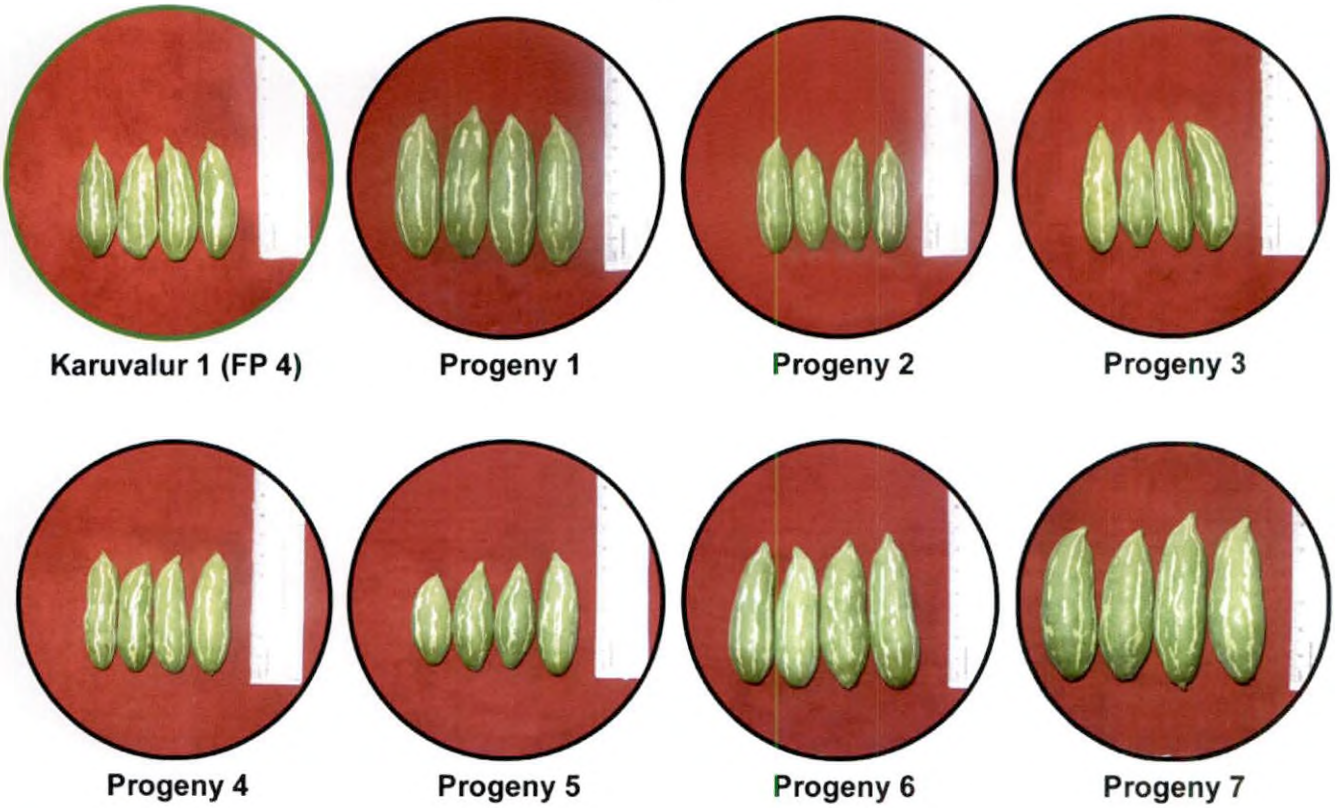
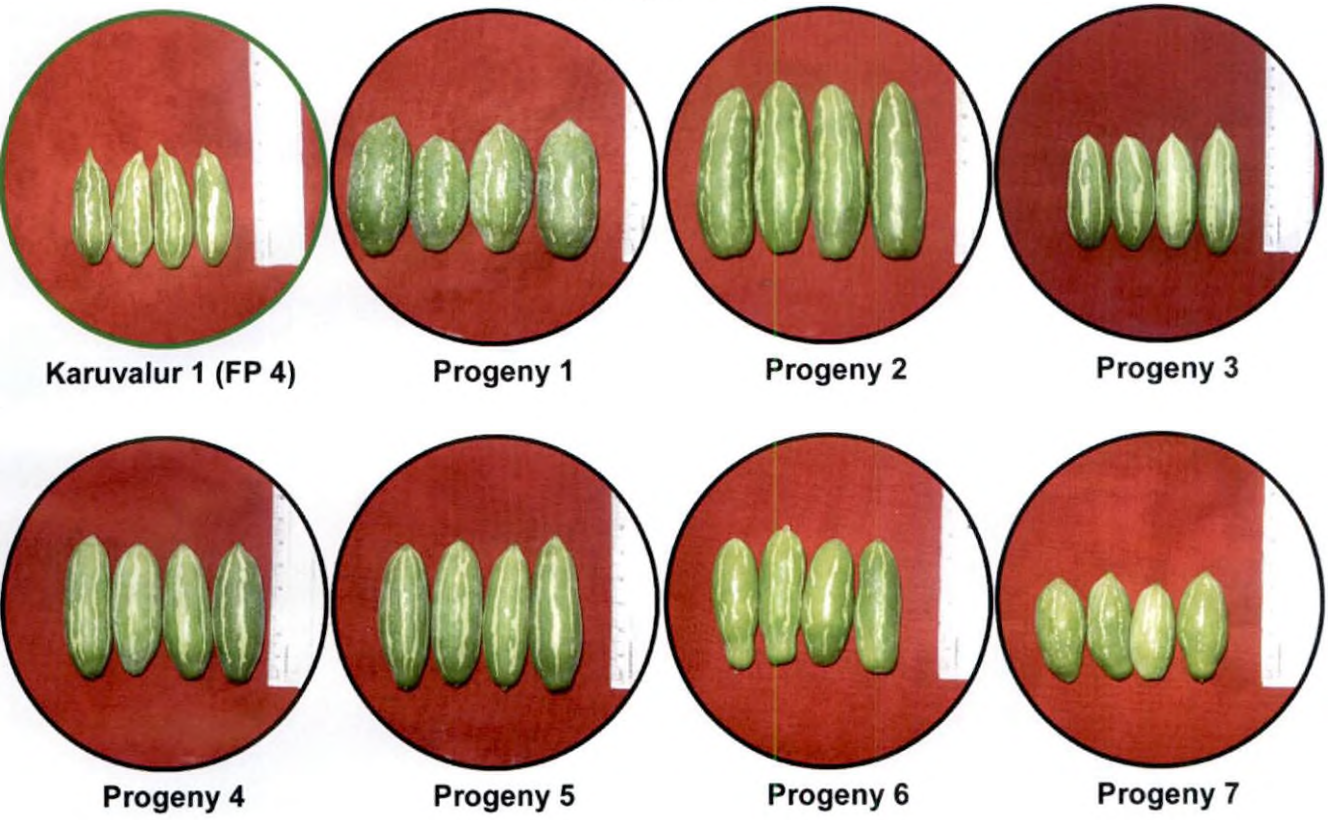


Plate 9

Variations in fruit characters among hybrid progenies

Hybrid 11 (FP 4 X MP 2)



Hybrid 12 (FP 4 X MP 3)

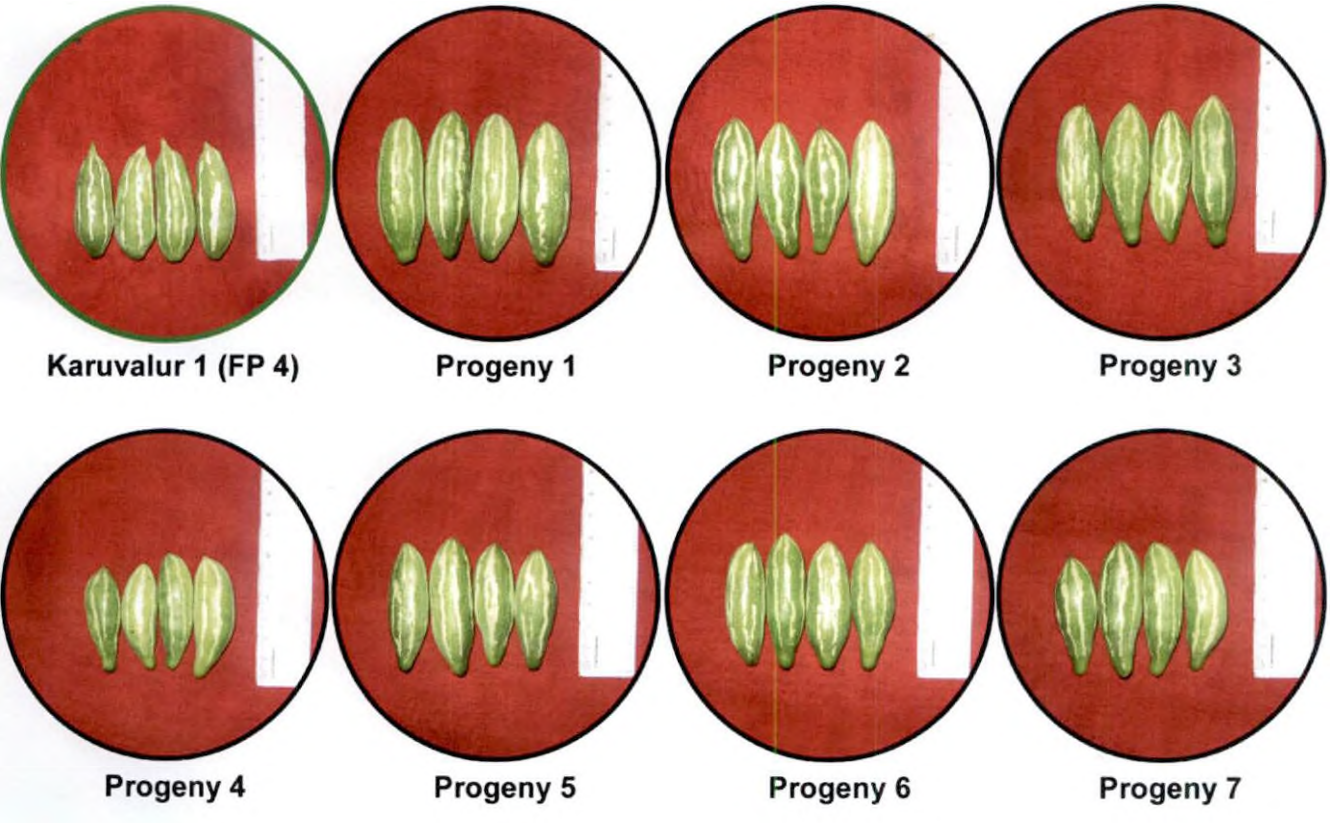


Plate 10

fruits per plant from 447.66 to 577.00, vitamin C content from 19.04 to 21.42 mg/100 g and fruit yield per plant from 7222.33 to 8686.33 g.

Family 2

Days to first flowering significant differences among the progenies of family 2 and ranged from 57.33 to 61.66 days. The progeny 5 (57.33 days) took minimum days to flowering which was on par with the progenies 7 (58.66 days), 6 (59.66 days), 4 (60.33 days) and 1 (60.66 days). The progeny 2 (61.66 days) took the maximum days to first flowering. There was no statistically significant difference in days to first harvest among the progeny of family 2 but exhibited a narrow range of 73.00 to 78.33 days.

Fruit length showed significant difference among the progenies. The mean values ranged from 6.69 to 7.27 cm. The maximum average fruit length was observed in the progeny 1 (7.27 cm) followed by 2 (7.19 cm). The minimum average fruit length was observed in 5 (6.69 cm) which was on par with the progenies 7 (6.72 cm), 4 (6.93 cm), 3 (7.07 cm), 6 (7.11 cm).

Average fruit girth showed significant difference among the progenies. The mean values ranged from 6.64 to 7.20 cm. The maximum average fruit girth was observed in the progeny 1 (7.20 cm). The minimum average fruit girth was observed in 3 (6.64 cm) which was on par with the progenies 7 (6.68 cm), 4 (6.87 cm), 6 (6.86 cm), and 2 (6.83 cm). The average fruit weight, number of fruits per plant, vitamin C and fruit yield per plant content showed no significant difference among the progenies. The mean values for average fruit weight ranged from 14.83 to 17.66g. The number of fruits per plant among the progenies of family 2 ranged from 415.00 to 501.00. The vitamin C mean values ranged from 15.26 to 17.19 mg/100g. The range of mean values for fruit yield per plant was 6399.66 g to 7662.00g.

Family 3

Significant differences were observed among the progenies of family 3 for days to first flowering. The mean values ranged from 48.66 to 54.33 days. The minimum number of days to first flowering was observed in the progeny1 (48.66 days) which was on par with the progenies 5 (49.33 days), 7 (49.66 days), 3 (50.66 days), 6 (50.66 days) and 2 (52.00 days). The progeny 4 (54.33 days) took the maximum number of days to first flowering. The number of days to first harvest showed no significant difference among the progenies. The mean values ranged from 75.00 to 79.66 days.

The average fruit length showed significant differences among the progenies. The mean values for this character ranged from 5.30 to 8.92 cm. The progeny 3 (8.92 cm) showed maximum fruit length. The minimum average fruit length was observed in the progeny 6 (5.30 cm) which was on par with the progenies 7 (7.51 cm), 4 (7.73 cm), 5 (7.82 cm), 2 (8.23 cm) and 1 (8.66 cm). The characters average fruit girth, average fruit weight, number of fruit per plant, and fruit yield per plant did not show any significant difference among the progenies. The mean values for these characters varied from 6.46 to 7.04 cm, 14.65 to 21.91 g, 333.66 to 458.00 and 5585.66 to 8487.00 g respectively. Vitamin C content showed significance differences in which the maximum vitamin C content was recorded in the progeny 3 (22.07 mg/100g) followed by 5 (20.88 mg/100g). The minimum vitamin C content was recorded in the progeny 4 (17.45 mg/100g) which was on par with he progenies 6 (17.98 mg/100g), 7 (17.98 mg/100g), 1 (18.25 mg/100g) and 2 (19.84 mg/100g). The mean values for this character ranged from 17.45 to 22.07 mg/100g.

Family 4

The mean values of days to first flowering ranged from 64.33 to 67.66 days. The minimum number of days to first flowering was observed in the progeny 2 (64.33 days) which was on par with 3 (65.00 days), 5 (65.66 days), 1 (66.00 days) and 7 (66.66 days) progenies. The progeny 4

(67.66 days) took maximum number of days to first flowering. Days to first harvest ranged from 78.66 to 84.66 days. The minimum number of days to first harvest was recorded in the progeny 7 (78.66 days) which was on par with the progenies 5 (79.00 days), 6 (79.66 days), 2 (79.66 days), and 3 (80.00 days). The maximum number of days to first harvest was observed in the progeny 4 (84.66 days) followed by the progeny 1 (83.33 days).

The average fruit length ranged from 4.08 to 5.48 cm. The mean values for average fruit girth ranged from 5.17 to 6.30 cm. The maximum average fruit girth was observed in the progeny 1 (6.30 cm) followed by 6 (5.85 cm). The minimum average fruit girth was observed in the progeny 4 (5.17 cm) which was on par with the progenies 5 (5.28 cm), 3 (5.66 cm), 7 (5.69 cm) and 2 (5.72 cm). Fruit weight ranged from 5.59 to 9.00 g. The maximum average fruit weight was observed in the progeny 1 (9.00g).The minimum average fruit weight was observed in the progeny 5 (5.59g) which was on par with all other the progenies 4 (6.25g), 2 (6.70g), 3 (6.75g), 7 (7.25g) and 6 (7.75g).

The maximum number fruits per plant were recorded in the progeny 1 (333.33). The mean values for number of fruits per plant ranged from 246.33 to 333.33. The progeny 5 (246.33) showed minimum number of fruits per plant which was on par with all other progenies, 4 (263.33), 2 (272.66), 7 (284.66), 6 (302.33), and 3 (306.33). The mean values for vitamin C ranged from 17.98 to 24.45 mg/100g. The maximum vitamin C content was observed in the progeny 1 (24.45 mg/100g). The progenies 3 (17.98 mg/100g) and 7 (17.98 mg/100g) recorded the minimum vitamin C content which was on par with 5 (19.44 mg/100g), 2 (19.57 mg/100g), and 6 (19.84 mg/100g). Fruit yield per plant ranged from 1489.00 to 2397.00g.The maximum fruit yield per plant was recorded in the progeny 1 (2397.00g) and the lowest fruit yield was observed in the progeny 5 (1459.00g) which was on par with 4 (1559.66g), 2 (1700.00g), 3 (2123.00g) and 6 (2263.33g) progenies.

Family 5

The mean values for days to first flowering ranged from 65.33 to 73.33 days. The progeny 1 took the minimum number of days to first flowering (65.33 days) which was on par with the progenies 2 (66.00 days), 3 (68.33 days) and 5 (69.33 days). The maximum number of days was taken by the progeny 7 (73.33 days) followed by 6 (72.66 days) and 4 (71.33 days). Days to first harvest also showed significant differences among the progenies and ranged from 71.66 to 84.33 days. The progeny 5 (71.66 days) took the minimum number of days to the first harvest which was on par with all other progenies 7 (74.33 days), 6 (76.66 days), 1 (78.33 days), 4 (80.00 days), 2 (84.33 days) except the progeny 2 (84.33 days). Average fruit length and average fruit girth did not show any significant difference among the progenies. The mean values for average fruit length ranged from 6.42 to 5.48 cm and for average fruit girth from 6.57 to 7.35 cm.

The average fruit weight showed significance difference among the progenies. The mean values for this character ranged from 12.50 to 16.25 g. The maximum fruit weight was recorded by the progeny 1 (16.25 g) followed by 6 (16.16 g). The minimum fruit weight was observed in the progeny 2 (12.50 g) which was on par with the progenies 3 (12.70 g), 4 (13.67 g), 7 (13.75 g) and 5 (13.96 g).

The number of fruits per plant showed no significant difference among the progenies. The mean values for this character ranged from 236.66 to 279.66. Vitamin C content varied significantly among the progenies. The mean values ranged from 13.75 to 21.16 mg/100g. The maximum vitamin C content was observed in the progeny 7 (21.16 mg/100g) followed by 3 (19.16 mg/100g) and the minimum vitamin C content was observed in the progeny 1 (13.75 mg/100g) which was on par with the progenies 5 (16.66 mg/100g), 2 (16.93 mg/100g), 6 (17.64 mg/100g), and 4 (18.02 mg/100g).

The fruit yield per plant showed significant difference among the progenies and ranged from 3445.66 to 4953.66 g. The maximum fruit yield per plant was observed in the progeny 6 (4953.66 g). The minimum fruit yield per plant was observed in the progeny 3 (3445.66 g) which was on par with the progenies 2 (3471.00 g), 5 (3981.00 g), 7 (4083.00 g), 4 (4123.00 g) and1 (4839.66 g).

Family 6

Days to first flowering showed significant differences among the progenies. The mean values ranged from 62.33 to 69.00 days. The progeny 4 (62.33 days) took the minimum number of days to first flowering which was on par with the progenies 3 (62.66 days), 5 (63.66 days), 6 (64.66 days), 7 (66.33 days) and 1 (67.33 days). The maximum number of days was taken by the progeny 2 (69.00 days). Days to first harvest showed no significant differences among the progenies. The mean values ranged from 77.33 to 80.66 days. Average fruit length showed significant differences among the progenies. The mean values for this character ranged from 6.20 to 7.38 cm. The maximum average fruit length was observed in the progeny 4 (7.38 cm). The minimum average fruit length was observed in the progeny 6 (6.20 cm) which was on par with other progenies 2 (6.52 cm), 5 (6.64 cm), 3 (6.69 cm), 1 (6.82 cm), and 7 (6.84 cm). Average fruit girth showed significant differences among the progenies. The mean values for this character ranged from 5.87 to 7.04 cm. The maximum average fruit girth was observed in the progeny 1 (7.04 cm) followed by 4 (6.97 cm). The minimum average fruit girth was observed in the progeny 6 (5.87 cm) which was on par with other progenies 5 (6.30 cm), 2 (6.55 cm), 7 (6.67 cm) and 3 (6.81 cm).

The average fruit weight showed no significance difference among the progenies. The mean values for this character ranged from 11.16 to 17.89 g. The number of fruits per plant showed significant difference among the progenies. The mean values for this character ranged from 208.66 to 269.66. The maximum number of fruits per pant was observed in

progeny 1 (269.66) followed by progeny 4 (259.00). The minimum number of fruits per pant was observed in progeny 2 (208.66) which was on par with 6 (215.00), 3 (225.66), 5 (229.33), and 7 (231.66). Vitamin C content showed no significant differences among the progenies. The mean values ranged from 19.16 to 23.80 mg/100g. The fruit yield per plant showed significant difference among the progenies. The mean values ranged from 2923.33 g to 4113.00 g. The maximum fruit yield per plant was observed in the progeny 4 (4113.00 g). The minimum Fruit yield per plant was observed in the progeny 6 (2923.33 g) which was on par with the progenies 1 (3050.66 g), 2 (3203.33 g), 7 (3213.00 g), 3 (3230.66 g) and 5 (3250.66 g).

Family 7

In this family the characters showed non significant differences among the progenies except days to first harvest and vitamin C. The mean values for days to first flowering ranged from 67.00 to 73.66 days. Days to first harvest showed significant difference among the progenies and the mean values ranged from 80.66 to 87.33 days. The progeny 6 (80.66 days) took minimum number of days to first harvest which was on par with the progenies 3 (82.00 days), 5 (82.00 days), 7 (83.66 days), and 4 (84.66 days). The progeny 1 (87.33 days) took maximum number of days to first harvest followed by the progeny 2 (87.00 days).

Average fruit length showed non significant differences among the progenies. The mean values for this character ranged from 5.60 to 6.44 cm. Average fruit girth showed non significant differences among the progenies. The mean values for this character ranged from 5.90 to 6.59 cm. Average fruit weight showed non significant differences among the progenies. The mean values for this character ranged from 9.75 to 13.58 g. Number of fruits per plant showed non significant differences among the progenies. The mean values for this character ranged from 233.00 to 279.33. Vitamin C content showed significant differences among the progenies. The mean values for this character ranged from 17.72 to 23.80

mg/100g. The maximum vitamin C content was observed in the progeny 2 (23.80 mg/100g). The minimum vitamin C content was observed in the progeny 4 (17.72 mg/100g) which was on par with the progenies 1 (18.25 mg/100g), 7 (18.78 mg/100g), 3 (19.57 mg/100g), 6 (20.48 mg/100g), and 5 (20.89 mg/100g). Fruit yield per plant showed no significant difference among the progenies. The mean values ranged from 2526.66 to 3654.33 g.

Family 8

Days to first flowering showed no significant differences among the progenies. The mean values ranged from 72.66 to 75.66 days. Days to first harvest showed no significant differences among the progenies. The mean values varied from 81.33 to 85.66 days. Average fruit length showed no significant differences among the progenies. The mean values for this character ranged from 5.20 to 5.74 cm. Average fruit girth showed significant differences among the progenies. The mean values for this character ranged from 5.81 to 6.98 cm. The maximum average fruit girth was observed in the progeny 7 (6.98 cm) which was on par with the progenies 6 (6.91 cm), 2 (6.80 cm), and 3 (6.60 cm). The minimum average fruit girth was observed in the progeny 5 (5.81 cm) which was on par with other progenies 4 (6.47 cm) and 1 (6.54 cm).

The average fruit weight showed significance difference among the progenies. The mean values for this character ranged from 10.50 to 12.74 g. The maximum average fruit weight was observed in the progeny 7 (12.74 g). The minimum average fruit weight was observed in the progeny 5 (10.50 g) which was on par with the progenies 1 (11.00 g), 4 (11.41 g), 2 (12.08 g), 3 (12.09 g) and 6 (12.33 g). The number of fruits per plant showed non significant difference among the progenies. The mean values for this character ranged from 274.33 to 321.66. Vitamin C content showed significant differences among the progenies. The mean values ranged from 19.31 to 23.54 mg/100g. The maximum vitamin C content was observed in the progeny 1 (23.54 mg/100g). The minimum vitamin C content was observed in the progeny 4 (19.31 mg/100g) which was on par

with the progenies 7 (19.42 mg/100g), 5 (1984 mg/100g), 3 (20.46 mg/100g), 2 (20.89 mg/100g) and 6 (21.16 mg/100g). Significant differences in fruit yield per plant among the progenies were not noticed. The mean values ranged from 3153.66 to 4124.33 g.

Family 9

Days to first flowering did not show any significant differences among the progenies. The mean values ranged from 67.66 to 69.33 days. Days to first harvest also showed non significant differences among the progenies. The mean values ranged from 73.33 to 77.66 days. Average fruit length showed significant differences among the progenies. The mean values for this character ranged from 5.41 to 6.79 cm. The maximum average fruit length was observed in the progeny 3 (6.79 cm) which was on par with progenies 5 (6.51 cm) and 1 (6.30 cm). The minimum average fruit length was observed in the progeny 4 (5.41 cm) which was on par with the progenies 6 (5.90 cm), 7 (5.93 cm) and 2 (5.97 cm).

Fruit girth showed no significant difference among the progenies. The values for this character ranged from 5.53 to 6.51 cm. The average fruit weight also showed non significance difference among the progenies. The mean values for this character ranged from 10.91 to 14.58 g.

The number of fruits per plant showed no significant difference among the progenies. The mean values for this character ranged from 263.00 to 322.66. Vitamin C content showed significant difference among the progenies. The mean values ranged from 15.87 to 19.31 mg/100g. The maximum vitamin C content was observed in the progeny 3 (19.31 mg/100g) which was on par with the progenies 6 (18.51 mg/100g) and 1 (17.98 mg/100g). The minimum vitamin C content was observed in the progeny 2 (15.87 mg/100g) which was on par with the progenies 7 (16.40 mg/100g), 5 (16.93 mg/100g) and 4 (17.19 mg/100g). The fruit yield per plant showed no significant difference among the progenies. The mean values ranged from 3159.00 to 3998.00 g.

Family 10

Days to first flowering showed no significant differences among the progenies. The mean values ranged from 73.00 to 75.66 days. Days to first harvest also showed no significant differences among the progenies. The mean values ranged from 89.33 to 91.66 days. Average fruit length showed significant differences among the progenies. The mean values for this character ranged from 6.35 to 6.99 cm. The maximum average fruit length was observed in the progeny 6 (6.99 cm) followed by 2 (6.98 cm). The minimum average fruit girth was observed in the progeny 5 (6.35 cm) which was on par with the progenies 3 (6.66 cm), 4 (6.85 cm) and 7 (6.91 cm). Average fruit girth showed no significant differences among the progenies. The mean values for this character ranged from 5.40 to 6.04 cm.

The average fruit weight showed significant difference among the progenies. The mean values for this character ranged from 10.16 to 13.66 g. The maximum average fruit weight was observed in the progeny 4 (13.66 g) followed by the progeny 2 (13.50 g). The minimum average fruit weight was observed in the progeny 5 (10.16 g) which was on par with the progenies 3 (11.20 g), 1 (11.62 g), 7 (12.41 g) and 6 (12.57 g). The number of fruits per plant showed non significant difference among the progenies. The mean values for this character ranged from 352.00 to 400.66. Vitamin C content showed non significant differences among the progenies. The mean values ranged from 16.66 to 18.25 mg/100g. The fruit yield per plant also showed non significant difference among the progenies. The mean values ranged from 3665.33 to 5023.33 g.

Family 11

Days to first flowering showed significant difference among the progenies. The mean values ranged from 80.00 to 87.00 days. The minimum number of days to first flowering was observed in the progeny 1 (80.00 days) which was on par with the progenies 4 (83.00 days), 5 (85.33 days), 6 (84.00 days) and 7 (85.33 days). The maximum number of days to first flowering

was taken by the progenies 2 (87.00 days) and 3 (87.00 days). Days to first harvest showed no significant difference among the progenies. The mean values ranged from 95.00 to 99.00 days. Average fruit length showed significant differences among the progenies. The mean values for this character ranged from 5.75 to 7.20 cm. The maximum average fruit length was observed in the progeny 2 (7.20 cm). The minimum average fruit length was observed in the progeny 7 (5.75 cm) which was on par with the progenies 4 (6.39 cm), 1 (6.48 cm), 5 (68.53 cm), 3 (6.74 cm) and 6 (6.75 cm). Average fruit girth showed no significant differences among the progenies. The mean values for this character ranged from 6.04 to 7.03 cm.

The average fruit weight showed non significant difference among the progenies. The mean values for this character ranged from 11.09 to 18.25 g. The number of fruits per plant showed significant difference among the progenies. The mean values for this character ranged from 232.00 to 383.66. The maximum number of fruits per plant was observed in the progeny 3 (383.66). The minimum number of fruits per plant was observed in the progeny 7 (232.00) which was on par with 4 (238.66), 6 (273.00), 5 (307.33), 1 (310.66) and 2 (319.66). Vitamin C content showed significant differences among the progenies. The mean values ranged from 17.19 to 20.21 mg/100g. The maximum vitamin C content was observed in the progeny 2 (20.21 mg/100g) followed by 3 (19.42 mg/100g). The minimum vitamin C was observed in the progeny 1 (17.19 mg/100g) which was on par with 5(17.98 mg/100g), 7 (17.98 mg/100g), 6 (19.04 mg/100g) and 4 (19.31 mg/100g). The fruit yield per plant showed non significant difference among the progenies. The mean values ranged from 3323.33 to 4035.66 g.

Family 12

Days to first flowering showed significant difference among the progenies. The mean values ranged from 83.66 to 90.33 days. The minimum number of days to first flowering was observed in the progeny 1 (83.66 days) which was on par with the progenies 4 (87.66 days), 7 (88.33 days), 6 (88.66 days) and 3 (89.00 days). The maximum number of days to first flowering

Table 4 Mean values of progenies for different characters

	Characters									
	Progenies	Days to first flowering	Days to first harvest	Average fruit length (g)	Average fruit girth (g)	Average fruit weight (g)	Number of fruits per plant	Vitamin C (mg/100 g)	Fruit yield per plant	Morphological characters
Family 1	1	48.00	65.00	8.42	7.30	21.64	468.66	20.36	7837.66	Light green with irregular white patches
	2	52.33	66.66	8.36	7.25	21.01	447.66	20.63	7222.33	Green with narrow white patches
	3	50.66	67.00	8.17	7.29	21.83	468.66	20.21	8433.00	Light green with narrow white streaks
	4	50.00	66.66	8.10	7.10	20.35	577.00	21.16	8686.33	Light green with broad prominent white streaks
	5	48.00	66.66	8.11	7.07	20.16	455.33	19.67	7311.33	Light green with irregular white patches
	6	50.33	67.00	7.92	7.09	19.41	464.66	21.42	7882.66	Light green with broad prominent white streaks
	7	48.66	67.33	8.22	7.00	18.83	448.33	19.04	7686.66	Light green with narrow white patches
Family 2	CD @ 5 %	NS	NS	NS	NS	NS	NS	NS	NS	
	1	60.66	77.66	7.27	7.20	17.25	501.00	17.19	7662.00	Green with irregular white patches
	2	61.66	77.33	7.19	6.83	16.08	450.33	15.26	6702.00	Light green with irregular white patches
	3	61.00	77.33	7.07	6.64	14.83	415.00	16.15	6399.66	Light green with irregular white patches
	4	60.33	75.66	6.93	6.87	16.51	439.00	15.32	6694.00	Green with irregular white patches
	5	57.33	75.66	6.69	7.19	16.66	468.33	15.26	7131.66	Light green with irregular white patches
	6	59.66	73.00	7.11	6.86	17.66	464.33	15.71	7261.66	Light green with irregular white patches
	7	58.66	78.33	6.72	6.68	15.25	415.33	16.66	6622.00	Green with irregular white patches
	CD @ 5 %	3.59	NS	0.55	0.40	NS	NS	NS	NS	

Table 4 continued...

Family 3	1	48.66	75.00	8.66	6.87	20.66	457.00	18.25	8487.00	Light green with narrow white patches
	2	52.00	76.33	8.23	6.74	20.75	431.00	19.84	7834.00	Light green with narrow white streaks
	3	50.66	79.33	8.92	7.04	21.91	458.00	22.07	8465.00	Light green with narrow white patches
	4	54.33	75.66	7.73	6.46	14.65	364.66	17.45	6078.00	Green with narrow white patches
	5	49.33	76.66	7.82	6.73	18.32	333.66	20.88	7106.66	Green with broad prominent white patches
	6	50.66	79.66	5.30	6.57	17.08	382.66	17.98	6485.66	Light green with irregular white patches
	7	49.66	77.66	7.51	6.66	16.50	365.33	17.98	5585.66	Green with broad regular white patches
Family 4	CD @ 5 %	5.52	NS	3.46	NS	NS	NS	3.03	NS	
	1	66.00	83.33	5.48	6.30	9.00	333.33	24.45	2397.00	Dark green with no white patches
	2	64.33	79.66	4.92	5.72	6.70	272.66	19.57	1700.33	Dark green with scattered white patches
	3	65.00	80.00	4.96	5.66	6.75	306.33	17.98	2123.00	Dark green with irregular white patches
	4	67.66	84.66	4.08	5.17	6.25	263.33	21.69	1559.66	Light green with scattered white patches
	5	65.66	79.00	4.12	5.28	5.59	246.33	19.44	1489.00	Dark green with irregular white patches
	6	67.66	79.66	4.91	5.85	7.75	302.33	19.84	2263.33	Dark green with irregular white patches
	7	66.66	78.66	4.86	5.69	7.25	284.66	17.98	2155.66	Dark green with irregular white patches
	CD @ 5 %	3.08	3.47	NS	0.65	2.95	64.26	5.16	773.98	
Family 5	1	65.33	78.33	6.83	7.35	16.25	279.66	13.75	4839.66	Light green, ashy coating with scattered white patches
	2	66.00	84.33	6.52	6.65	12.50	253.00	16.93	3471.00	Green, ashy coat with broad white patches
	3	68.33	82.00	6.53	6.68	12.70	236.66	19.16	3445.66	Light green, ashy coat with scattered white patches
	4	71.33	80.00	6.55	6.80	13.67	254.00	18.02	4123.00	Green with irregular white patches
	5	69.33	71.66	6.63	6.68	13.96	248.00	16.66	3981.00	Green, ashy coat with irregular white patches
	6	72.66	76.66	6.68	7.25	16.16	274.66	17.64	4953.66	Dark green, ashy coat with scattered white spots
	7	73.33	74.33	6.42	6.57	13.75	260.66	21.16	4083.00	Dark green, ashy coat with scattered white spots
	CD @ 5 %	4.22	10.66	NS	NS	3.36	NS	4.97	1478.18	

Table 4 continued...

Family 6	1	67.33	77.66	6.82	7.04	13.66	269.66	19.84	3050.66	Green with irregular white patches
	2	69.00	78.00	6.52	6.55	13.49	208.66	21.16	3203.33	Dark green with irregular white patches
	3	62.66	77.33	6.69	6.81	14.82	225.66	23.80	3230.66	Green with irregular white patches
	4	62.33	77.66	7.38	6.97	17.89	259.00	21.42	4113.00	Dark green with irregular white patches
	5	63.66	78.33	6.64	6.30	13.16	229.33	19.16	3250.66	Green with irregular white patches
	6	64.66	80.66	6.20	5.87	11.16	215.00	20.89	2923.33	Green with irregular white patches
	7	66.33	79.33	6.84	6.67	14.91	231.66	19.69	3213.00	Green with irregular white patches
	CD @ 5 %	6.38	4.15	NS	1.04	NS	38.63	NS	1040.02	
Family 7	1	69.00	87.33	6.36	6.59	13.00	279.33	18.25	3654.33	Green with irregular white patches
	2	73.66	87.00	6.20	6.45	12.75	266.00	23.80	3415.33	Dark green with irregular white patches
	3	69.00	82.00	5.60	5.90	9.75	233.00	19.57	2526.66	Light green with narrow white patches
	4	70.00	84.66	6.44	6.48	13.58	260.33	17.72	3565.33	Dark green with irregular white patches
	5	67.00	82.00	5.94	6.24	11.75	256.00	20.89	3338.33	Dark green with irregular white patches
	6	68.66	80.66	6.06	6.36	12.58	269.33	20.48	3467.33	Dark green with irregular white patches
	7	73.66	83.66	5.73	6.13	12.16	258.00	18.78	3242.66	Light green with irregular white patches
	CD @ 5 %	NS	5.70	NS	NS	NS	NS	5.71	NS	
Family 8	1	74.00	85.66	5.20	6.54	11.00	291.33	23.54	3343.00	Green with broad regular white patches
	2	75.66	85.33	5.42	6.80	12.08	300.66	20.89	3791.66	Green with scattered white patches
	3	73.66	82.33	5.62	6.60	12.09	291.66	20.46	3960.66	Light green with scattered white patches
	4	72.66	84.66	5.31	6.47	11.41	305.33	19.31	3441.33	Light green with scattered white patches
	5	72.66	82.00	5.41	5.81	10.50	274.33	19.84	3153.66	Green with scattered white patches
	6	73.33	81.33	5.42	6.91	12.33	321.66	21.16	4124.33	Green with irregular white patches
	7	73.33	82.66	5.74	6.98	12.74	317.33	19.42	4082.33	Green with broad prominent white streaks
	CD @ 5 %	NS	NS	NS	0.76	2.11	NS	2.89	NS	

Table 4 continued...

Family 9	1	68.00	77.00	6.04	6.30	13.25	295.00	17.98	3725.33	Dark green with irregular white patches
	2	69.33	77.66	5.97	6.10	14.58	298.66	15.87	3755.00	Green with irregular white patches
	3	68.33	75.00	6.79	6.27	13.50	301.00	19.31	3998.00	Light green with broad irregular white patches
	4	67.66	73.33	5.41	5.53	10.91	275.33	17.19	3159.00	Green with irregular white patches
	5	67.66	74.00	6.51	6.51	13.75	322.66	16.93	3980.00	Dark green with irregular white patches
	6	67.66	75.33	5.90	5.67	11.25	263.00	18.51	3174.00	Green with scattered white patches
	7	68.00	74.66	5.93	6.01	11.75	287.66	16.40	3521.00	Light green with irregular white patches
	CD @ 5 %	NS	NS	0.61	NS	NS	NS	2.82	NS	
Family 10	1	75.00	90.00	6.81	5.65	11.62	376.33	17.72	4434.00	Light green with narrow white patches
	2	75.66	89.66	6.98	6.04	13.50	396.33	16.66	4917.66	Green with narrow white patches
	3	73.00	90.66	6.66	5.89	11.20	373.66	17.98	4424.33	Light green with irregular white patches
	4	73..00	90.33	6.85	5.89	13.66	400.66	17.72	5023.33	Light green with irregular white patches
	5	74.00	89.33	6.35	5.40	10.16	352.00	17.72	3665.33	Light green with irregular white patches
	6	74.00	89.33	6.99	5.81	12.57	370.00	18.25	4297.00	Light green with irregular white patches
	7	74.33	91.66	6.91	6.03	12.41	375.66	17.98	4323.00	Light green with irregular white patches
	CD @ 5 %	NS	NS	0.62	NS	2.91	NS	NS	NS	
Family 11	1	80.00	97.33	6.48	7.03	14.97	310.66	17.19	3893.00	Green with irregular white patches
	2	87.00	98.66	7.20	6.21	16.33	319.66	20.21	3792.33	Green with irregular white patches
	3	87.00	96.33	6.74	6.94	18.25	383.66	19.42	4035.66	Green with narrow white streaks
	4	83.00	95.00	6.39	6.17	12.67	238.66	19.31	3421.00	Green with narrow white streaks
	5	83.66	99.00	6.53	6.18	13.46	307.33	17.98	3562.66	Green, with narrow white streaks
	6	84.00	95.33	6.75	6.64	14.50	273.00	19.04	3466.66	Light green with irregular white patches
	7	85.33	96.33	5.75	6.04	11.09	232.00	17.98	3323.33	Light green with irregular white patches
	CD @ 5 %	6.78	NS	1.08	NS	NS	159.85	1.90	NS	

Table 4 continued...

Family 12	1	83.66	101.00	6.35	6.18	10.95	228.66	16.40	3115.00	Light green, regular white patches with white spots
	2	89.33	102.00	6.33	6.11	10.00	216.33	17.72	3121.66	Light green, regular white patches with white spots
	3	89.00	101.00	5.60	5.43	9.25	212.66	17.19	3198.33	Light green, irregular white patches
	4	87.66	102.00	5.97	5.63	10.00	213.33	17.19	2916.00	Light green, irregular white patches with white spots
	5	90.33	100.33	6.64	6.19	10.75	225.66	16.40	2941.66	Light green, regular white patches with white spots
	6	88.66	100.33	6.12	5.85	10.54	211.00	15.34	3263.33	Light green, irregular white patches with white spots
	7	88.33	101.33	6.44	6.09	10.83	232.00	16.66	3115.66	Light green, regular white patches with white spots
	CD @ 5 %	5.55	NS	NS	NS	NS	NS	1.77	NS	
CD @ 5 % progenies in different family		9.63	6.36	1.27	0.84	4.54	99.63	4.00	1822.86	

was taken by the progeny 5 (90.33 days) followed by 2 (89.33 days) progenies. Days to first harvest showed no significant difference among the progenies. The mean values ranged from 100.33 to 102.00 days. Average fruit length showed no significant differences among the progenies. The mean values for this character ranged from 5.60 to 6.64 cm. Average fruit girth also showed no significant differences among the progenies. The mean values for this character ranged from 5.43 to 6.19 cm.

The average fruit weight showed non significance difference among the progenies. The mean values for this character ranged from 9.25 to 10.95 g. The number of fruits per plant also showed non significant difference among the progenies. The mean values for this character ranged from 211.00 to 232.00. Vitamin C content showed significant differences among the progenies. The mean values ranged from 15.34 to 17.72 mg/100g. The maximum vitamin C content was observed in the progeny 2 (17.72 mg/100g) followed by the progenies 3 (17.19 mg/100g) and 4 (17.19 mg/100g). The minimum vitamin C content was observed in the progeny 6 (15.34 mg/100g) which was on par with 1 (16.40 mg/100g), 5 (16.40 mg/100g) and 7 (16.66 mg/100g). The fruit yield per plant showed non significant difference among the progenies. The mean values ranged from 2916.00 to 3263.33 g.

4.1.3 Variability among the progenies of 12 different families (pooled analysis)

The pooled analysis of the data showed significant difference among the progenies for all the characters. The variations for days to first flowering ranged from 48.00 to 90.33 days. The minimum days to flowering was recorded in progeny 1 and 5 of family 1 followed by progeny 7 of the same family and progeny 1 of family 3 (48.33). The maximum time for flowering (90.33) was taken by progeny 5 of family 12. All progenies of family 12 took more than 83 days. All progenies of family 1 generally took less than 53 days for flowering.

The same trend was observed for days to first harvest of fruits. The progeny 1 of family 1 was found to be earliest to harvest within 65 days. It

was followed by three other progenies viz., progeny 2, 4 and 5 which took 66.66 days. The progenies 3 and 6 of the same family 3 and 6 took 67 days and progeny 7 took 67.33 days. The progenies of family 12 recorded more than 100 days for harvest. The maximum duration (102.00 days) was taken by progenies 2 and 4.

Significant variation for average fruit length was observed among the progenies. Progeny 1 of family 1 recorded the longest fruits having the length of 8.42 cm. All other progenies of the same family except progeny 6 produced fruits having more than 8 cm. The shortest fruits having an average length of 4.08 cm were produced by progeny 4 of family 4. The progenies of different families recorded a wide range of variation from 4.08 to 8.42 cm. The magnitude of variation was high for fruit girth. The progeny 4 of family 4 recorded the lowest fruit girth (5.17 cm). The highest fruit girth was observed in progeny 1 of family 5 (7.35 cm).

Average fruit weight was found to be highly variable from 5.59 to 21.91 cm among the progenies. The progeny 3 of family 3 produced fruits having the maximum weight followed by progeny 3 of family 1 (21.83).

Analysis of the pooled data revealed significant differences among the progenies for number of fruits. The mean values ranged from 208.66 to 577.00. The maximum number of fruits was produced by progeny 4 of family 1 and the minimum was recorded by progeny 2 of family 6.

Significant variation ranging from 13.75 to 24.45 mg/100g was recorded among the progenies for vitamin C content of fruits. Progeny 1 of family 4 recorded the highest vitamin C content and the lowest being in progeny 1 of family 5.

Fruit yield per plant showed significant variation ranging from 1489.00 to 8686.33g among the progenies of 12 families. The highest yield was recorded by progeny 4 of family 1 followed by progeny 1 of family 3 (8487.00) and progeny 3 (8465.00) of the same family.

4.1.3 Coefficients of variation

The estimates of the components of variance viz., phenotypic and genotypic coefficients of variation are given in Table 5 fig.1.

Phenotypic coefficient of variation (PCV) was found to be slightly higher than genotypic coefficient of variation (GCV) for all the biometric characters studied.

The phenotypic coefficient of variation ranged from 7.78 to 44.06. The maximum phenotypic coefficient of variation was recorded for fruit yield per plant (44.06) followed by number of fruits per plant (29.35), average fruit weight (27.66), days to first flowering (17.97), average fruit weight (15.39), days to first harvest (12.17) and vitamin C content (10.29). The minimum PCV was observed for average fruit girth (7.78).

The genotypic coefficient of variation ranged from 7.15 to 42.17. The highest genotypic coefficient of variation was recorded for fruit yield per plant (42.17) followed by number of fruits per plant (26.93), average fruit weight (25.79), days to first flowering (16.26), average fruit length (14.14), days to first fruit harvest (11.71) and vitamin C content (8.23).The lowest GCV of variation was observed for average fruit girth (7.15).

4.1.4 Heritability and Genetic advance

Heritability estimates ranged from 63.87 to 92.48 per cent (Table 5 fig.2). The highest heritability estimates was recorded for days to first harvest (92.48 per cent) followed by fruit yield per plant (91.59 per cent), average fruit weight (86.92 per cent), average fruit length (84.43 per cent), average fruit girth (84.36 per cent), number of fruits per plant (84.18 per cent) and days to first flowering (81.91 per cent). The lowest heritability estimates was recorded for vitamin C content (63.87 per cent).

Genetic advance as per cent of mean ranged from 13.53 to 83.13. The highest genetic advance was recorded for fruit yield per plant (83.13 per cent) followed by number of fruits per plant (50.90 per cent), average

fruit weight (49.53 per cent), days to first flowering (30.32 per cent), average fruit length (26.74 per cent), days to first harvest (23.20 per cent) and vitamin C content (13.55 per cent). The least genetic advance expressed for average fruit girth (13.53 per cent).

Table 5 Genetic components of variation

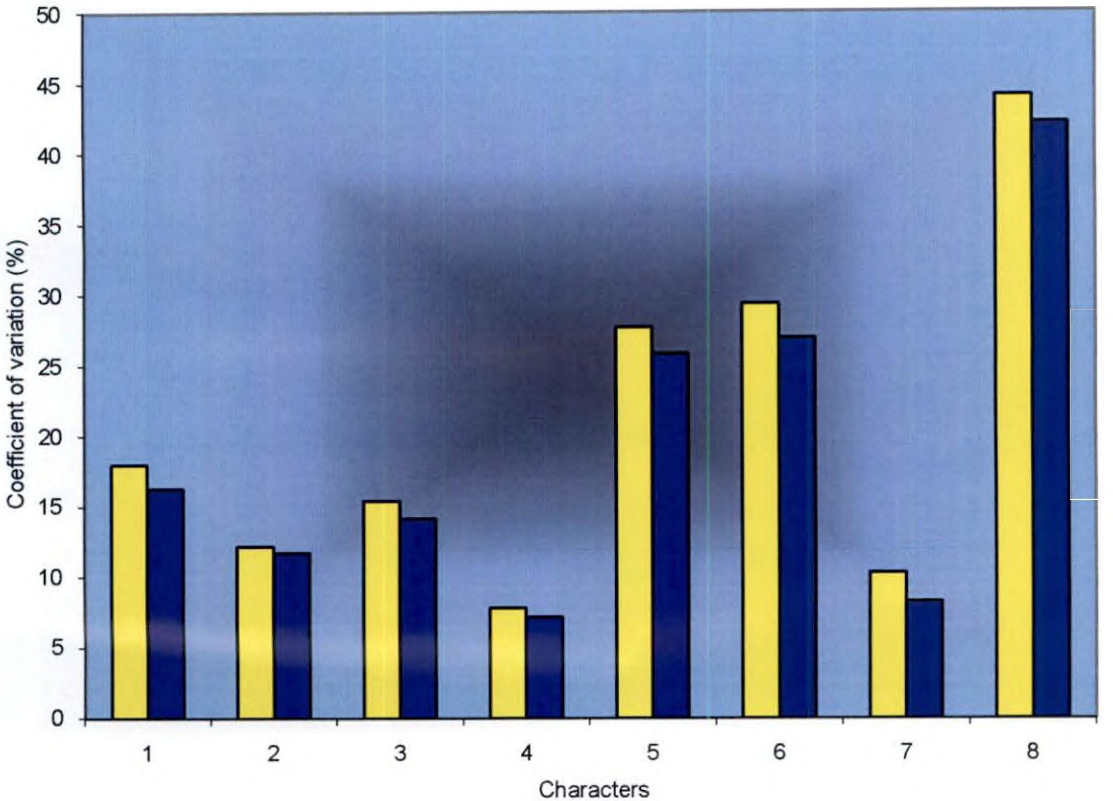
Sl. no	Characters	PCV	GCV	Heritability (%)	Genetic advance (% of mean)
1	Days to first flowering	17.97	16.26	81.91	30.32
2	Days to first harvest	12.17	11.71	92.48	23.20
3	Average fruit length (cm)	15.39	14.14	84.43	26.74
4	Average fruit girth (cm)	7.78	7.15	84.36	13.53
5	Average fruit weight (g)	27.66	25.79	86.92	49.53
6	No. of fruits per plant	29.35	26.93	84.18	50.90
7	Vitamin C	10.29	8.23	63.87	13.55
8	Fruit yield per plant (g)	44.06	42.17	91.59	83.13

4.1.5 Correlation analysis

4.1.5.1 Phenotypic correlation

Phenotypic correlation coefficients estimated for eight characters are presented in Table 6

Days to first flowering showed positive association (0.852) with days to first harvest and showed significant negative correlation with fruit yield per plant (-0.688), number of fruits per plant (-0.605), average fruit weight (-0.542) and average fruit length (-0.484). Negative association was noticed for days to first harvest with all other characters. Average fruit length showed positive correlation with average fruit weight (0.876),



1. Days to first flowering
2. Days to first harvest
3. Average fruit length
4. Average fruit girth
5. Average fruit weight
6. Number of fruits per plant
7. Vitamin C
8. Fruit yield per plant

Phenotypic coefficient of variation Genotypic coefficient of variation

Fig. 1 Phenotypic and geotypic coeffficient of variation of eight characters of ivy gourd

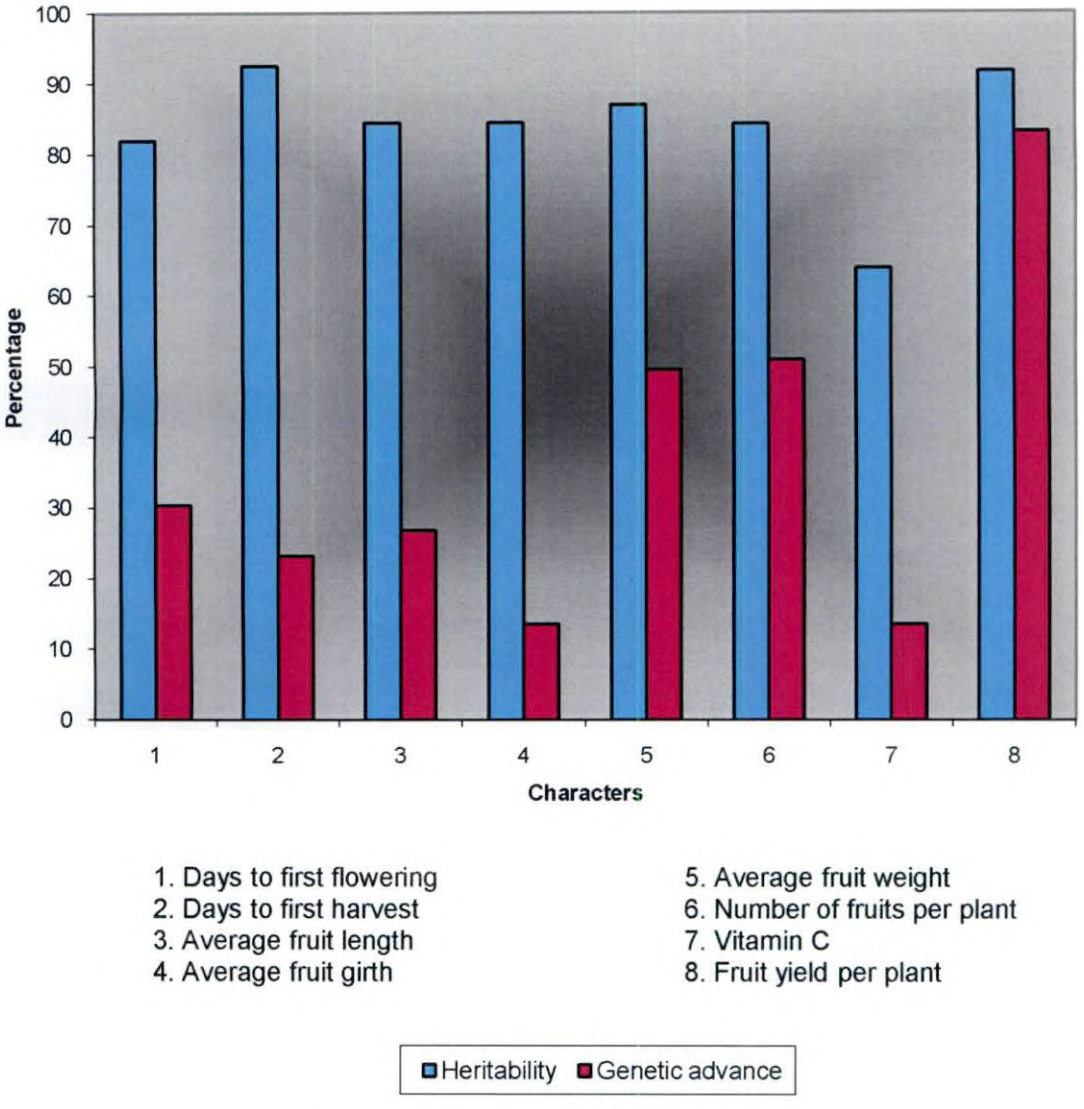


Fig. 2 Heriatability and genetic advance for eight characters in ivy gourd

fruit yield per plant (0.831), number of fruits per plants (0.612) and average fruit girth (0.592). Average fruit length showed negative phenotypic correlation with days to first flower (-0.484) and days to first fruit harvest (-0.307).

Average fruit girth showed significant positive correlation with average fruit weight (0.772), fruit yield per plant (0.638), and significant negative correlation was recorded with days to first fruit harvest (-0.487).

Average fruit weight recorded significant positive association with average fruit length (0.876), fruit yield per plant (0.836), average fruit girth (0.772) and number of fruits per plant (0.663) and significant negative correlation with days to first flowering (-0.542).

Fruit yield per plant recorded significant positive phenotypic correlation with average fruit weight (0.836), average fruit length (0.831), number of fruits per plant (0.663) and average fruit girth (0.638). Significant negative association was noticed with days to first flowering (-0.688) and days to first harvest (-0.497).

The number of fruits per plant recorded significant positive correlation with fruit yield per plant (0.872), average fruit weight (0.663) and average fruit length (0.612). Significant negative association was recorded with days to first flower (-0.605). The vitamin C content of the fruits had no significant correlation with any other characters.

4.1.5.2 Genotypic correlation

The genotypic correlation for different characters is presented in Table 7.

The number of days to flower had significant positive genotypic correlation with days to first fruit harvest (0.929) and negative association with all other characters. Days to first harvest showed significant negative correlation with all other characters except days to first flower. Average fruit length showed significant positive genotype correlation with average fruit weight (0.963), fruit yield per plant (0.898), average fruit girth (0.726) and number of fruits per plant (0.717) and significant negative

Table 6 Phenotypic correlation coefficient

Character	X1	X2	X3	X4	X5	X6	X7	X8
X1	1.000							
X2	0.852**	1.000						
X3	-0.484*	-0.307	1.000					
X4	-0.430	-0.487*	0.592*	1.000				
X5	-0.542*	-0.407	0.876**	0.772**	1.000			
X6	-0.688**	-0.497*	0.831**	0.638**	0.836**	1.000		
X7	-0.605*	-0.437	0.612*	0.414	0.663**	0.872**	1.000	
X8	-0.251	-0.286	-0.090	0.109	0.060	-0.090	-0.097	1.000

X 1 = Days to first flowering, X 2 = Days to first harvest, X 3 = Average fruit length, (cm) X 4 = Average fruit girth (cm)

X 5 = Average fruit weight (g) X 6 = Fruit yield per plant (g) X 7 = Number of fruits per plant X 8 = Vitamin C

Table 7 Genotypic correlation coefficient

Character	X1	X2	X3	X4	X5	X6	X7	X8
X1	1.000							
X2	0.929**	1.000						
X3	-0.588*	-0.372	1.000					
X4	-0.608*	-0.559*	0.726**	1.000				
X5	-0.639**	-0.496*	0.963**	0.866**	1.000			
X6	-0.780**	-0.566*	0.898**	0.699**	0.887**	1.000		
X7	-0.738**	-0.549*	0.717**	0.453	0.700**	0.902**	1.000	
X8	-0.364	-0.372	-0.081	0.216	0.038	-0.088	-0.084	1.000

X 1 = Days to first flowering, X 2 = Days to first harvest, X 3 = Average fruit length (cm), X 4 = Average fruit girth (cm),

X 5 = Average fruit weight (g), X 6 = Fruit yield per plant (g), X 7 = Number of fruits per plant, X 8 = Vitamin C (mg/100g)

Table 8 Environmental correlation coefficient

Character	X1	X2	X3	X4	X5	X6	X7	X8
X1	1.000							
X2	0.371	1.000						
X3	0.028	0.193	1.000					
X4	0.449	0.058	-0.127	1.000				
X5	-0.019	0.376	0.358	0.214	1.000			
X6	-0.097	0.303	0.360	0.207	0.425	1.000		
X7	0.045	0.430	0.050	0.206	0.443	0.689**	1.000	
X8	0.047	-0.002	-0.128	-0.208	0.144	-0.126	-0.148	1.000

X 1 = Days to first flowering, 2 = Days to first harvest, X 3 = Average fruit length (cm), X 4 = Average fruit girth (cm),

X 5 = Average fruit weight (g), X 6 = Fruit yield per plant (g), X 7 = Number of fruits per plant, X 8 = Vitamin C (mg/100g)

correlation was observed with days to first flower (-0.588) and non significant negative correlation with days to first harvest (-0.372).

Positive genotypic correlation was recorded for average fruit girth with average fruit weight (0.866), average fruit length (0.726) and fruit yield per plant (0.699) and significant negative correlation was recorded with days to first flower (-0.608) and days to first harvest (-0.559).

Average fruit weight recorded significant positive genotypic correlation with average fruit length (0.963), fruit yield per plant (0.0887), average fruit girth (0.866) and number of fruits per plant (0.700). Significant negative correlation was recorded with days to first flower (-0.639) and days to first harvest (-0.496).

Fruit yield pert plant showed significant positive genotypic correlation with number of fruits per plant (0.902), average fruit length (0.898), average fruit weight (0.887) and average fruit girth (0.699). Significant negative genotypic correlation was showed with days to first flower (0.780) and days to first fruit harvest (-0.566).

Significant positive genotypic correlation was recorded for number of fruits per plant with fruit yield per plant (0.902), average fruit length (0.717) and average fruit weight (0.700). Significant negative correlation was observed with days to first flower (-0.738) and days to first harvest (-0.549). There was no significant correlation for vitamin C content with any other characters.

The estimates of the environmental correlation coefficient of variation presented in Table 8 showed no significant correlation except for fruit yield per plant.

4.1.6 Path analysis

The direct and indirect effect of different characters on yield is presented in Table 9 and Fig. 3.

Fruit yield per plant had positive correlation with length of fruit (0.898), girth of fruit (0.699), average fruit weight (0.887) and number of fruits per plant (0.902). Vitamin C content of fruit had negative

Table 9 Direct and indirect effects

	X1	X2	X3	X4	X5	X6	X7	Correlation
X 1	**0.088**	-0.169	-0.783	-0.378	0.884	-0.438	0.017	-0.780
X 2	0.082	**-0.182**	-0.495	-0.348	0.686	-0.326	0.018	-0.566
X 3	-0.052	0.067	**1.333**	0.452	-1.333	0.426	0.003	-0.898
X 4	-0.054	0.101	0.967	**0.623**	-1.198	0.269	-0.010	0.699
X 5	-0.056	0.090	1.283	0.539	**-1.384**	0.416	-0.001	0.887
X 6	-0.065	0.100	0.955	0.282	-0.968	**0.594**	0.003	0.902
X 7	-0.032	0.067	-0.107	0.134	-0.052	-0.049	**-0.047**	-0.088

Residual effect = 0.1448

X 1 = Days to first flowering

X 2 = Days to first harvest

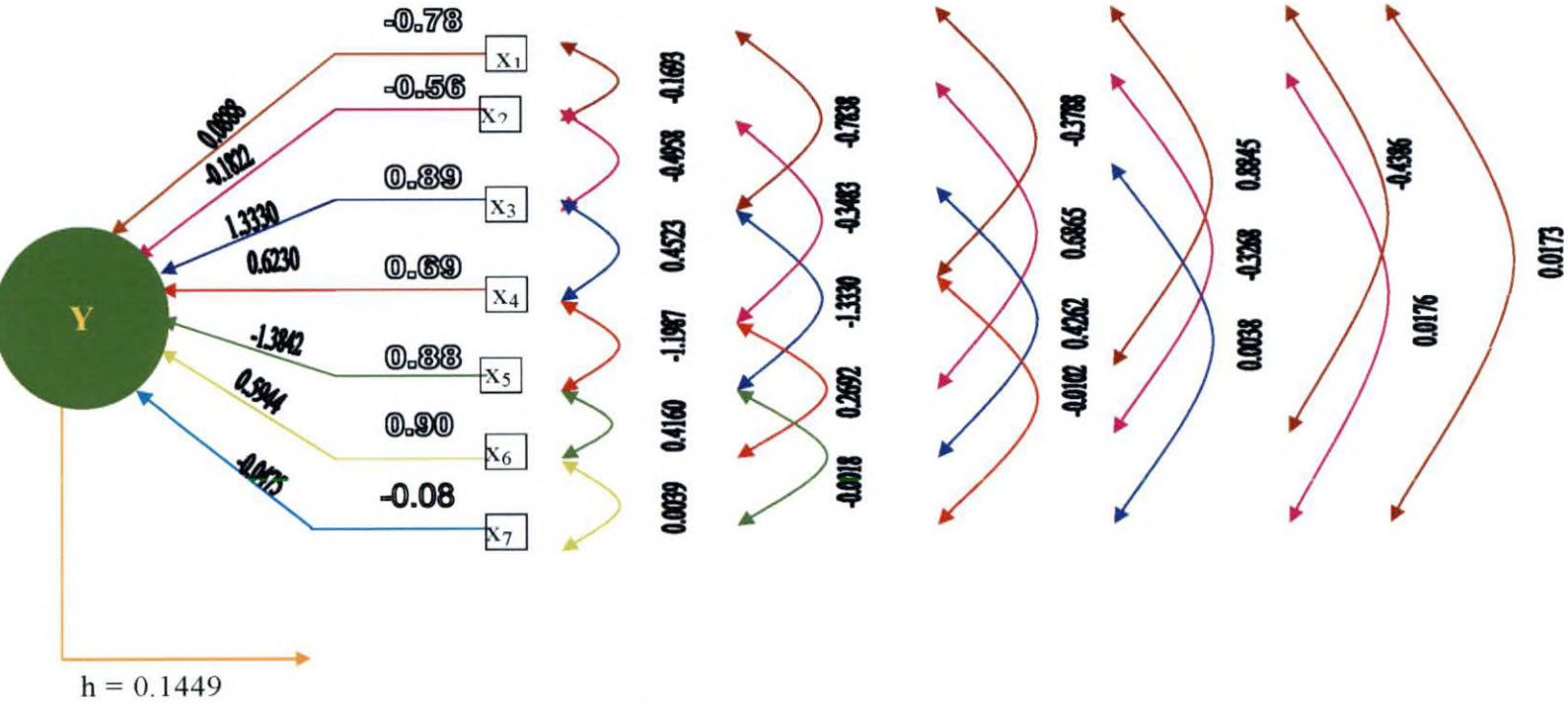
X 3 = Average fruit length (cm)

X 4 = Average fruit girth (cm)

X 5 = Average fruit weight (g)

X 6 = Number of fruits per plant

X 7 = Vitamin C (mg/100g)



Direct effects given in straight lines and correlations in curved lines

X1	Days to first flowering	X4	Average fruit girth
X2	Days to first harvest	X5	Average fruit weight
X3	Average fruit length	X6	Number of fruits per plant
		X7	Vitamin C

Fig. 3 Path diagram showing direct and indirect effects of components on yield

correlation with yield. The average length of fruit has the maximum direct effect on yield (1.333) followed by girth of fruits (0.623), number of fruits per plant (0.594). However days to first fruit harvest and vitamin C content recorded negative direct effect with fruit yield.

Number of days to flower (x_1) had positive direct effect (0.088) and negative correlation (-0.780). Number of days to first harvest (x_2) and vitamin C content of fruits (x_7) recorded negative genotypic correlation (-0.169) and negative direct effect (-0.047) respectively. Average weight of fruit (x_5) recorded negative direct effect (-1.384) and positive genotypic correlation (0.884) and it had high indirect effect through average length of fruits (x_3), average girth of fruits (x_4) and number of fruits per plant (x_6). The direct effect of number of fruits per plant (x_6) is positive (0.594) which is indirectly contributed by length of fruits (x_3) and girth of fruits (x_4).

The average length of fruits recorded the highest direct effect (1.333) and it had positive correlation (0.898). The residual effect (r = 0.1448) indicated that the selected characters explain the total correlation well and the remaining characters have minor contributions on the variability of yield.

4.1.7 Standard heterosis

The standard heterosis was estimated in comparison with the standard check variety "Sulabha" for different characters are presented in Table 10 and Fig. 4

Days to first flowering

Days to first flowering showed positive heterosis among the families ranging from 2.52 to 81.79 per cent. The family F_1 recorded the lowest percentage (2.52) followed by the families F_3 (4.50 per cent) and F_2 (23.30 per cent). The maximum percentage was expressed by the family F_{12} (81.80 per cent).

Days to first harvest

Positive heterosis for days to first fruit harvest ranged from 2.10 to 56.30 per cent. The minimum percentage was recorded by the family F_1 (2.09 per cent) followed by the families F_9 (15.52 per cent), F_2 (18.35 per cent), F_3 (19.44 per cent), F_5 (20.05 per cent) and F_6 (20.43 per cent). The maximum percentage was expressed by the family F_{12} (56.30 per cent).

Average fruit length

Two families viz, F_1 (6.11 per cent) and F_3 (3.56 per cent) recorded positive heterosis for average fruit length. The negative heterosis ranged from -9.92 to -38.04 per cent. The maximum negative heterosis was observed in the family F_4 (-38.04 per cent) followed by the families F_8 (-29.01 per cent), F_9 (-22.01 per cent), F_7 (-21.76 per cent), F_{12} (-19.85 per cent) and F_5 (-14.75 per cent). The minimum negative heterosis was recorded in the family F_2 (-9.92 per cent) followed by the families F_{10} (-12.21 per cent), F_6 (-13.36 per cent) and F_{11} (-13.74).

Average fruit girth

The positive heterosis ranged from 0.45 to 11.96 per cent for average fruit girth. The maximum percentage was observed in the family F_1 (11.96 per cent) followed by the families F_5 (8.69 per cent), F_2 (8.23 per cent), F_3 (6.67 per cent) and F_6 (5.12 per cent). The minimum positive heterosis was observed in the family F_7 (0.45 per cent) followed by the families F_{11} (2.47 per cent) and F_8 (2.78 per cent). The negative heterosis for this character ranged from to -5.15 to -10.74 per cent. The maximum negative heterosis was observed in the family F_4 (-10.74 per cent) followed by F_{10} (-9.03 per cent) and F_{12} (-6.23 per cent). The minimum negative heterosis was observed in the family F_9 (-5.15 per cent).

Average fruit weight

The positive heterosis for average fruit weight was observed in the families F_1 (17.42 per cent) and F_3 (12.60 per cent). The negative heterosis for this character ranged from -6.08 to -58.26 per cent.

The maximum negative heterosis was recorded in the family F_4 (-58.26 per cent) followed by the families F_{12} (-40.81 per cent), F_8 (-31.04 per cent), F_{10} (-29.03 per cent), F_7 (-26.95 per cent), F_9 (-26.50 per cent), F_5 (-17.25 per cent) and F_6 (-16.18 per cent). The minimum negative heterosis was observed in the family F_2 (-6.08 per cent) followed by the family F_{11} (-6.81 per cent)

Number of fruits per plant

Four families recorded positive heterosis for number of fruits per plant which ranged from 7.31 to 40.58 per cent. The maximum positive heterosis was observed in the family F_1 (40.58 per cent) followed by F_2 (30.98 per cent), F_3 (18.44 per cent) and F_{10} (7.31 per cent). The negative heterosis for this character ranged from -11.16 to -38.35 per cent. The maximum negative heterosis was observed in the family F_{12} (-38.35 per cent) followed by F_6 (-32.65 per cent), F_5 (-27.66 per cent), F_7 (-26.06 per cent), F_4 (-17.85) and F_9 (-16.19 per cent). The minimum negative heterosis was observed in the family F_{11} (-11.16 per cent) followed by the family F_8 (-15.48 per cent).

Vitamin C

The positive heterosis for vitamin C content was ranged from 0.45 to 17.73 per cent. The maximum positive heterosis was observed in the family F_6 (17.73 per cent) followed by the families F_1 (16.78 per cent), F_7 (16.39 per cent), F_8 (16.17 per cent), F_4 (15.17 per cent) and F_{11} (5.52 per cent). The minimum positive heterosis was observed in the family F_{10} (0.45 per cent) followed by the families F_5 (2.85 per cent). The negative heterosis was recorded by three families which ranched from -1.17 to -9.03 per cent. The maximum negative heterosis was recorded in the family F_2 (-9.32 per cent) followed by the families F_{12} (-6.24 per cent) and F_9 (-1.17 per cent).

Fruit yield per plant

The positive heterosis for fruit yield per plant was observed in the families F_1 (37.76 per cent), F_3 (33.60 per cent) and F_2 (18.34 per cent).

The negative heterosis for this character ranged from -21.84 to -63.93 per cent. The maximum negative heterosis was observed in the family F_4 (-63.93 per cent) followed by the families F_{12} (-47.80 per cent), F_6 (-42.36 per cent), F_7 (-39.93 per cent), F_{11} (-38.57 per cent) and F_9 (-35.01 per cent). The minimum negative heterosis was observed in the families F_{10} (-21.84 per cent) and F_5 (-29.48 per cent).

Table.10 Standard heterosis (%) for eight characters of 12 families of ivy gourd

Families	Days to first flowering	Days to first harvest	Average fruit length	Average fruit girth	Average fruit weight	Number of fruits per plant	Vitamin C	Fruit yield per plant
F_1	2.52*	2.10*	6.11*	11.96*	17.43*	40.58*	16.78*	37.76*
F_2	23.31*	18.35*	-9.92	8.23*	-6.08	30.98*	-9.03	18.34*
F_3	4.50*	19.44*	3.56*	6.67*	12.60*	18.44*	8.31*	33.60*
F_4	36.18*	24.54*	-38.04	-10.74	-58.26	-17.85	15.17*	-63.93
F_5	42.25*	20.05*	-14.36	8.69*	-17.25	-27.66	2.85*	-29.48
F_6	34.03*	20.43*	-13.36	5.12*	-16.18	-32.65	17.73*	-42.36
F_7	44.26*	30.29*	-21.76	0.45*	-26.95	-26.06	16.39*	-39.93
F_8	51.18*	28.95*	-29.01	2.78*	-31.05	-15.48	16.17*	-35.01
F_9	40.00*	15.52*	-22.01	-5.15	-26.50	-16.19	-1.17	-37.59
F_{10}	52.69*	39.54*	-12.21	-9.03	-29.03	7.31*	0.45*	-21.84
F_{11}	73.55*	49.14*	-13.74	2.47*	-6.81	-11.16	5.52*	-38.57
F_{12}	81.80*	56.30*	-19.85	-6.24	-40.81	-38.35	-6.24	-47.80

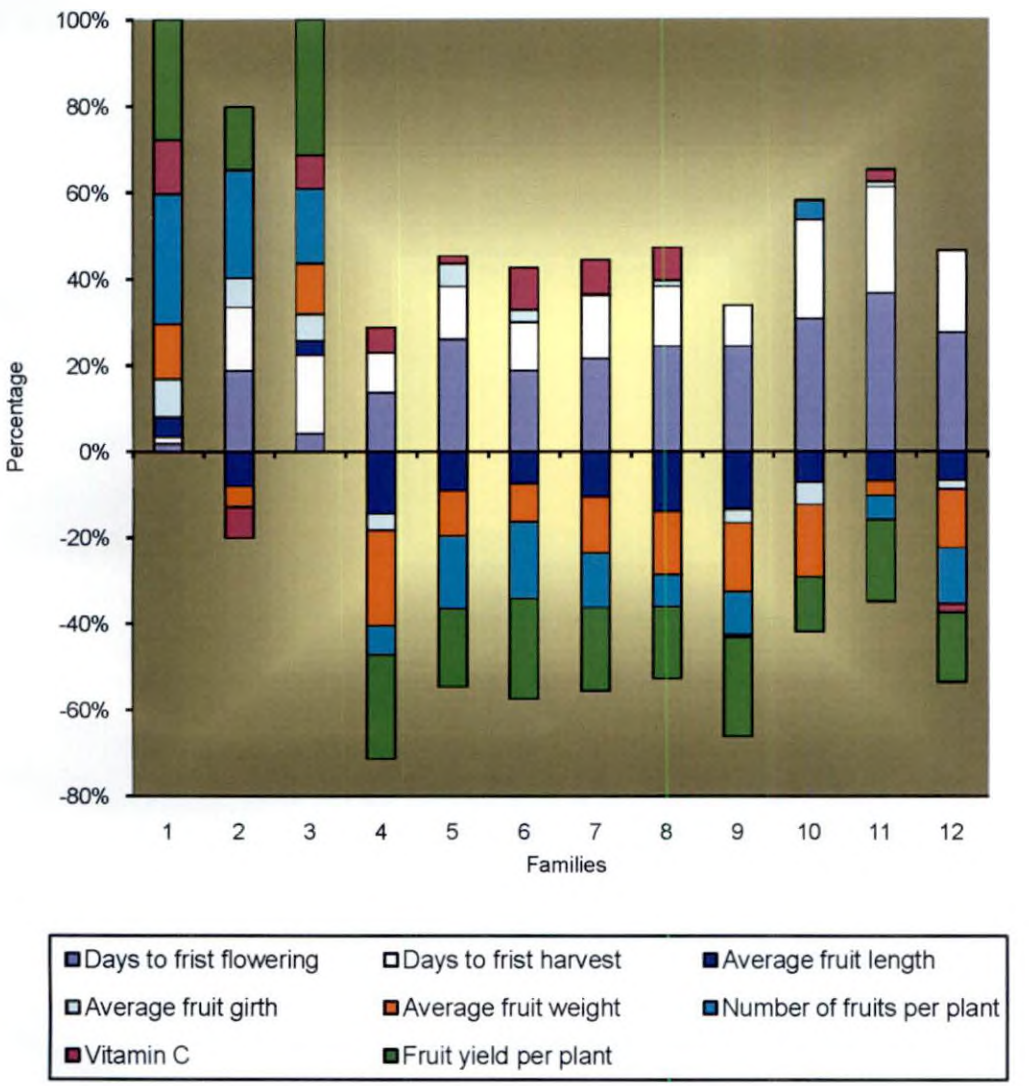


Fig. 4 Standard heterosis among the 12 families of ivy gourd

DISCUSSION

5. DISCUSSION

The results of the experiment conducted on "Development and evaluation of hybrids in ivy gourd (*Coccinia grandis* L. Voigt.) are discussed in this chapter.

Evaluation of hybrids

Ivy gourd is a typical dioecious crop. The tender parthenocarpic fruits are used as vegetable. Being a clonally propagated crop conventional biometric approach to study heterosis combining ability and gene action is not possible especially for the yield and yield attributes. However viable seeds can be produced with help of male parents.

Morphologically distinct male plants have been identified in different ivy gourd growing tracts. In this investigation attempts were made to study the variation induced by hybridization between different female parents and morphologically distinct male parents. Ivy gourd is highly heterozygous because it is cross pollinated in nature. A desirable attribute of clonally propagated plants amenable to seed production is fixation of heterosis in F_1 generation.

Variability among the F_1 families

The analysis of variance conducted for 12 F_1 families of ivy gourd showed significant differences among the progenies for the different characters studied. This clearly showed that the families are different from each other. The compact family block design used for the conduct of experiment provides an opportunity to assess the variability among and within the families. Since fixation of heterosis is possible in F_1 generation, identification of superior hybrid progeny is useful for developing a hybrid clone.

There was significant variation among the families for days to first flowering which is evident from the range of variation showed for this character. Early flowering is a desirable attribute. Two families F_1 and F_2 produced using the same female parent was significantly different from the rest for days to flowering. However the other two crosses produced using the same female parent did not show any significant difference in the days taken for first flower opening. The family 12 took the maximum number of days for flowering. Joseph (1999) and Varghese (2003) also reported a wide range of variation for days to flowering in ivy gourd.

The family 1 which took the minimum days for flowering also took minimum days for first harvest. The family 12 took maximum days for flowering and days for first harvest of fruit.

There were significant differences among the families for average fruit length and girth of fruits. The family 1 recorded the maximum length and girth of fruits.

The number of fruits per plant showed significant differences among the families. The family 1 (Royappanpatty 1 x Royappanatty local)produced the maximum number of fruits and was on par with family 1 (Royappanpatty 1 x Vellayani local). The family 1 was found to be the best to give the highest fruit yield. The family 12 recorded the lowest fruit yield per plant. The vitamin C content of the fruits also showed significant difference among the families. Among the twelve families family 1 was found to be best for seven out of eight characters. Hence it is possible to select plants from this family for desirable traits.

Variability among the progenies

The mean values of progenies for different characters showed wide variation among the progenies of the same parentage. The compact family block design facilitates the analysis of progeny of different families.

The variation for different characters among the progenies in family 1 was not significant. It indicates the homogeneity of the progenies. The progenies of family 1 had desirable attributes like early flowering, early fruit harvest, longest fruits, more number of fruits and fruit yield per plant. Hence all progenies of family 1 can be selected for further evaluation. But significant variation was observed for days to first flowering and vitamin C content in Family 2. The F_1 population is highly heterozygous and heterogeneous in nature. The progeny 7 of the family 2 took the minimum days for the first harvest of fruits. Variation within the family was observed for fruit length. The progenies 1 and 2 were significantly different from other progenies for fruit length. The progeny 1 was found to have the maximum fruit girth. Fruit length and fruit girth are desirable traits.

The progenies having desirable traits can be selected from this family.

The variations showed for the number of fruits and fruit yield per plant was found to be not significant. Hence all the progenies can be selected for getting more number of fruits and better fruit yield. The variations among the progenies were significant for days to first flowering and vitamin C content.

Among the progenies of family 3 (Royappanpatty 1 x Karyavattam) significant variations was observed for days to flowering. The progeny 1 was the earliest to flower. For fruit length progeny 3 was significantly superior to the rest. The progenies in general had desirable traits viz., fruit girth, weight, number of fruits and fruit yield per plant for which no significant difference was noticed among the progenies. Hence all the progenies can be utilized for further improvement programmes. Selection of progeny 3 is desirable of early flowering.

Maximum heterogeneity among the progenies was observed in family 4. Significant variations were recorded for all the characters except for average fruit length. Progenies for various desirable characters can be selected from this family. In family 4, progeny 2 took the minimum days for first flowering. However early harvest was taken from progeny 7 of the same family. Among the different progenies in family 4, progeny 1 had the maximum girth of fruit. The same progeny also recorded the maximum weight and number of fruits and yield per plant. Progeny 1 can be selected from family 4 because of the desirable yield attributes for further evaluation.

Among the different progenies of family 5 significant variations was recorded for days to first flowering, days to first fruit harvest, average fruit weight, vitamin C content and fruit yield per plant. The progeny 1 took minimum days for flowering followed by progeny 2. Regarding the early harvest of fruits progeny 5 came first followed by progeny 7. The variations among the progenies for fruit length and fruit girth were not significant. Average fruit weight showed significant differences among the progenies. Progeny 1 of family 5 recorded the maximum fruit weight. Significant variation was observed for vitamin C content of fruits. Progeny 7 of family 5 had the maximum content of vitamin C. Significant variations among the progenies of family 5 were recorded for fruit yield per plant. The progeny 6 recorded the maximum fruit yield and can be selected.

The progenies of family 6 showed significant variations for days to first flower but the variation was not significant for days first fruit harvest. The progenies showed significant variation for average fruit length. Progeny 4 recorded the highest value for average fruit length. Average fruit girth also showed significant variation among the progenies. Progeny 1 recorded the highest fruit girth.

There was significant variation among the progenies in family 6 for fruit yield per plant. Progeny 4 recorded the maximum fruit yield per plant. The same progeny

also had the maximum girth of fruits. Progeny 4 can be selected from family 6 for further evaluation.

Heterogeneity for different characters was less in family 7. Out of the eight characters significant differences among the progenies were observed only for days to first fruit harvest and vitamin C content. Progeny 6 took the minimum days for fruit harvest. For vitamin C content progeny 2 was found to be the best.

The variations shown among the progenies in family 8 were not significant for day to first flowering, day to fruit harvest, average length of fruit, number of fruits per plant and fruit yield per plant. Average girth of fruit showed significant differences among the progenies. Progeny 7 had the maximum average fruit girth which was on par with progeny 6. Average fruit weight had significant differences among the progenies. The maximum average fruit weight was recorded in the progeny 7. Progeny 7 can be selected for maximum length and girth of fruits.

Significant variation for average fruit length and vitamin C content was observed among the progenies in family 9. The average fruit length was the maximum in progeny 3 which was on par with the progeny 5 and 1. The progeny 3 had the highest content of vitamin C in family 9. Within family variation for other characters were not significant.

Family 10 showed significant variation among progenies for fruit length and fruit weight. The progeny 6 produced fruits with the maximum average length whereas progeny 4 produced fruits having the maximum average weight. The variation shown for other characters were not found to be significant.

The family 11 showed significant differences among the progenies for four characters viz., days to first flowering, average fruit length, number of fruits per plant and vitamin C content. The progeny 1 took the minimum number of days for flowering. The progeny 2 produced fruits having the maximum average length. The progeny 3 produced the maximum number of fruits. There was no significant difference among the progenies for other characters.

Significant variation among the progenies for days for first flowering and vitamin C content was noticed in family 12.

The magnitude of variation shown among the progenies of 12 families revealed the heterogeneous nature of the F_1 families. Significant variations among the progenies for vitamin C content was expressed in eight families viz., family 3 ,4, 5, 7, 9, 11 and 12. Seven families viz., family 2, 3, 4, 5, 6, 11 and 12 showed significant

variations among progenies for days to first flowering. Variations among progenies for fruit length were expressed by the families 2, 3, 4, 6, 9, 10, and 11. The families 4, 5, 8 and 10 showed significant variations for average fruit length among the progenies. The families 4, 5 and 7 showed variations among progenies for days to first fruit harvest. The families 2, 6 and 8 showed variations among the progenies for girth of fruits. Families 4, 6 and 11 recorded significant variations among the progenies for number of fruits. Only two families viz., families 4 and 6 showed significant variations among progenies for fruit yield per plant.

Variability among the progenies of 12 different families (pooled analysis)

The pooled analysis of the data showed significant difference among the progenies for all the characters. The minimum days to flowering was recorded in progeny 1 and 5 of family 1 followed by progeny 7 of the same family and progeny 1 of family 3. The maximum time for flowering was taken by progeny 5 of family 12. The same trend was observed for days to first harvest of fruits. The progeny 1 of family 1 was found to be earliest to take harvest. It was followed by three other progenies viz., progeny 2, 5 and 6.

Significant variation for average fruit length was observed among the progenies. Progeny 1 of family 1 recorded the longest fruits. The shortest fruits were produced by progeny 4 of family 4. The progeny 4 of family 4 recorded the lowest value for fruit girth. The highest fruit girth was observed in progeny 1 of family 4. The progeny 3 of family 3 produced fruits having the maximum weight followed by progeny 3 of family 1 Analysis of the pooled data revealed significant differences among the progenies for number of fruits. The maximum number of fruits was produced by progeny 4 of family 1 and the minimum was recorded by progeny 2 of family 6.

Significant variation was recorded among the progenies. Progeny 1 of family 4 recorded the highest vitamin C content and the lowest being in progeny 2 and 4 of family 4.

The highest fruit yield was recorded by progeny 3 of family 1 followed by progeny 1 of family 3 and progeny 3 of the same family. Most of the families showed highly heterogeneous nature for different characters. Therefore superior progenies identified for different characters from the hybrid population can be utilized for further improvement. The advantage of clonal propagation and fixation of heterosis in the F_1 generation promotes the development hybrid

clones in ivy gourd. In the present investigation seedling progenies were analysed. Cuttings from the selected plants can be used for growing the next generation for the evaluation of hybrid clones.

Variability and Genetic parameters

The results of the analysis of variance showed significant differences among the genotypes for all the characters studied viz., days to first flowering, days to first fruit harvest, average length of fruits, average girth of fruits, average weight of fruits, number of fruits per plant, vitamin C content and fruit yield per plant.

The genetic parameters of different characters in 12 families of ivy gourd were estimated in this study. In ivy gourd heterosis can be fixed in F_1 generation because of the clonal propagation. Selection of plants in F_1 population helps to identify desirable clones. Selection of desirable plants from a genetically variable population is the basic step in crop improvement. The success of selection and extent of progress in a selection programme depends upon the magnitude of variability existing in a crop. In crops like ivy gourd hybridization is one of the methods to induce variability.

A wide range of variation observed among the hybrid population in this study indicated the scope for selection. The variability available in a population could be partitioned into heritable and non-heritable components with the aid of genetic parameters like genotypic coefficient of variation (GCV), heritability (h^2) and genetic advance which serve as useful guidelines for selection.

The phenotypic coefficient of variation (PCV) was found to be higher than genotype coefficient of variation for all the characters studied. Bhave et al. (2002) in bitter gourd and Choudhary and Sharma (2002) in ridge gourd also reported that phenotypic coefficient of variation was higher than GCV for all the characters they studied. High estimates of PCV and GCV were observed for fruit yield per plant followed by number of fruits per plant. Suresh (2004) also reported the highest PCV and GCV for fruit yield per plant followed by number of fruits per plant in ivy gourd. Similar reports were also reported by Kandaswamy (2004) in muskmelon. Joseph (1999), Varghese (2003) and Wilson et al. (2006) also reported high PCV and GCV for fruit yield per plant. High PCV and GCV for fruit yield per plant was also reported by Gayathri (1997), Rastogi and Deep (1990) in cucumber, Swamy and Dutta (1985) in musk melon, Vahab (1989) in bitter gourd, Varghese (1991), Varghese and Rajan (1993) in snake gourd.

Parmer and Tarsen Lal (2005) reported the highest PCV and GCV for number of fruits per plant in muskmelon. The phenotypic and genotypic coefficients of variation were found to be low for average fruit girth whereas GCV for average weight of fruit (27.66) was high. Mathew et al. (2001) reported high GCV values (22.40) for average fruit weight in bottle gourd. The GCV for fruit length estimated in the study was 14.14. In bottle gourd Mathew et al. 2001 reported a higher estimate (24.80) of GCV for fruit length. The GCV for days to first flowering was 16.26. However Gayathri (1997) in cucumber, Varghese and Rajan (1993) in snake gourd and George (1981) in ash gourd reported the low estimates of GCV for days to first flowering.

The GCV was comparatively low for days to first harvest. Similar results were also reported by Varghese and Rajan (1993) in snake gourd.

The vitamin C content of fruit also recorded low estimates PCV and GCV values. Varghese (2003) reported that the variability for vitamin C content of fruit is less than 20 per cent.

The lowest PCV and GCV values were estimated for average fruit girth. Tyagi (1972) reported a high estimate of GCV for girth of fruits in bitter gourd.

The GCV provides a valid basis for comparing and assessing the range of genetic variability and PCV measures the extent of total variation. High values of PCV with correspondingly high values of GCV observed for fruit yield per plant, number of fruits per plant and average fruit weight indicated the presence of high degree of genetic component of variation and better scope for improvement through selection. Low estimates of GCV for average fruit girth of fruits, vitamin C content of fruits and days to first harvest indicated limited scope for improvement of these traits.

For all the characters PCV and GCV values were found to be closer indicating the predominant influence of genetic component over the environmental effect for these characters.

Heritability and Genetic advance

Heritability estimates provide exact and precise information of the influences of environment on various characters. Robinson et al. (1966) classified heritability into low (< 30 per cent), medium (30-60 per cent) and high (> 60 per cent). Burton (1952) suggested that GCV along with heritability would provide a picture of the account of advance to be expected by genotype selection.

High heritability was recorded for all the characters in this study. The highest heritability of 92.48 per cent was recorded for days to first harvest followed by fruit yield per plant, average fruit weight, average fruit length, average fruit girth, number of fruits per plant, days to first flowering and vitamin C content. The high heritability of more than 60 per cent recorded for all the characters may be due to the fact that these characters are least influenced by the environment. This is in line with the findings of Suresh (2004) in ivy gourd. Johnson et al. (1955) pointed out that high heritability estimates along with high genetic advance were more useful than the heritability estimates alone in predicting the resultant effect for selecting the best plant.

High heritability estimates were obtained for fruit yield per plant followed by number of fruits per plant, average fruit weight and days to first flowering. The lowest heritability estimates were recorded for vitamin C content followed by average girth of fruits, days to first flowering, days to first harvest and average fruit length.

High heritability and high genetic advance estimated for fruit yield per plant, number of fruits per plant and average fruit weight in this study is in line with the findings of Suresh (2004) in ivy gourd. The lowest genetic advance recorded for average fruit girth in the study is in conformity with the reports of Wilson et al. (2006) in the same crop and Varalakshmi et al. (1955) in ridge gourd and Sarkar et al. (1990) in pointed gourd. However Lovely and Radhadevi (2007) reported high heritability coupled with high genetic advance for fruit girth in ash gourd.

Gayathri (1997) in cucumber and Anitha (1998) in ridge gourd has also reported high genetic advance for yield per plant, average fruit weight and number of fruits per plant.

Gayathri (1997) in cucumber, Anitha (1998) in ridge gourd, Mathew and Khader (1999) in snake gourd and Bindu et al. (2000) in pumpkin also reported high heritability and genetic advance for fruit yield per plant, average fruit weight and number of fruits per plant.

The differences between PCV and GCV were very low for all the characters and indicated the major contribution genetic component of variation. High heritability estimates coupled with high genetic advance for important characters like fruit yield per plant, average fruit weight and number of fruits per plant indicated the effectiveness selection of for the improvement of these characters.

Correlation analysis

Yield is a complex character influenced by a number of other component characters. For successful improvement through selection it is essential to ascertain the importance and extent of inter association with yield. The extent of relationship between yield and its component traits as well as among the component traits is revealed through correlation analysis.

The genotypic correlation between the characters provides a reliable measure of genetic association between the characters and helps to differentiate the vital association useful in breeding from the non-vital ones (Falconer, 1981)

The genotypic correlations were higher than the phenotypic correlation for most of the characters indicating the reduced influence of environment for variation of characters. Saroj Rohana et al. 2003 also obtained similar results in water melon.
Fruit yield per plant showed significant positive genotypic correlation with number of fruits per plant, average fruit length, average fruit weight and average fruit girth. This is in line with the findings of Joseph (1999) and Sarnaik et al. (1999) in ivy gourd. Similar results were also reported by Rastogi and Deep (1999), Ma et al. (1995) and Rao et al. (2004) in cucumber, Lawande and Patil (1989) in bitter gourd, Shibukumar (1995) in water melon, Singh et al. (1993) and Sarkar et al. (1999) in pointed gourd. Positive correlation indicates the importance of these traits in improving fruit yield.

Fruit yield per plant was found to be negatively correlated with days to first flowering and days to first harvest. Varghese (2003) and Suresh (2004) also reported the negative correlation of days to first flowering with fruit yield. Similar results were also reported by Rastogi and Deep (1990) and Damarany et al. (1995) in cucumber, Lawande and Patil (1990) in bitter gourd, Shibukumar (1995) in water melon and Prasad and Singh (1990) in pointed gourd. However, positive correlation of yield with days to flower was also reported by Pynadath (1978) in snake gourd and Anitha (1998) in ridge gourd. Negative correlation of yield with days to first fruit harvest was also reported by Anitha (1988) in ridge gourd.

Number of fruits per plant showed significant positive correlation with fruit yield per plant, average fruit length and average fruit weight. From these positive associations it can be inferred that simultaneous improvement of these characters is possible. Average fruit weight also had significant positive correlation with average fruit length, average fruit girth and fruit yield per plant. Vitamin C content of fruit did not show any significant correlation with yield or any other characters.

Path analysis

As the correlation coefficients are insufficient to explain the cause and effect relationship among the traits for an effective manipulation of the characters, the path analysis was carried out. The path analysis furnishes a method of partitioning the correlation coefficients into direct and indirect effects and provides the actual contribution of an attribute and its influence through other traits.

Average length of fruits, girth of fruits, average weight of fruits and number of fruits per plant exerted significant positive direct effect on fruit yield per plant. Therefore improvement of anyone of these characters can bring out simultaneous improvement of yield. This is in conformity with the findings of Varghese (2003) in ivy gourd. Positive direct effect of fruit weight and fruit length on yield had been reported by Prasad and Singh (1992) in cucumber. Positive direct effect of number of fruit and weight of fruits has also been reported by Saika et al. (1995) and Gayathri (1997) and Rao et al. (2004) in the same crop and Bhave et al. (2003) in bitter gourd. Days to flowering had negative correlation and positive direct effect in this study. Shibukumar (1995) in water melon and Dhaliwal et al. (1996) in musk melon reported positive direct effect of days to flowering on yield.

Standard heterosis

The families showed standard heterosis at varying levels for different characters. In this study mean values of the families were taken for comparison with the standard parent. The progenies were found to be highly heterogeneous. Since heterosis can be fixed in F_1 generation due to clonal propagation superior plants having desirable traits can be selected for further evaluation.

Early flowering is a desirable trait. Compared to the standard check "Sulapba" the hybrid population took more days to flower. However among the hybrid progenies family 1 took the minimum days to flower. Family 12 recorded 81.8 per cent heterosis which is not a desirable attribute. Gayathri (1997) in cucumber also reported heterosis for days to flower, whereas Ram et al. (1997) observed negative heterosis for days to flower.

The family which took minimum days to flower was also found to be the earliest to harvest. All the hybrid progenies showed positive heterosis for days to first fruit harvest. Similar result was also reported by Varghese and Rajan (1993b). But, Mandal and Sirohi (2002) observed heterosis for early maturity in ash gourd.

The magnitude of heterosis for length and girth of fruits were low. Only two families manifested marginal positive heterosis for fruit length. All other families expressed negative heterosis. Significant heterosis for fruit length was reported by Kasem and Somsak (1991) in cucumber, Mishra et al. (1994) in snake guard, and Pandey et al. (2002) in pumpkin.

Heterosis for fruit girth was exhibited by eight families and four families expressed heterosis in the negative direction. Negative heterosis for fruit girth was also noticed by Pyzhenkov and Kosareva (1979). Imam et al. (1977) and Kasem and Somsak (1991) also reported positive heterosis for fruit girth in cucumber.

Only two hybrids were found to have positive heterosis and all other hybrids had negative heterosis for fruit weight. Heterosis for fruit weight was also reported by Pyzhenkov and Kosareva (1979), Fang et al. (1994), Kasem and Somsak (1991) in cucumber and Pandey et al. (2002) in pumpkin.

Regarding the fruit number, four hybrid progenies expressed positive heterosis, other families were inferior to the check variety. Pyzhenkov and Kosareva (1979), Fang et al. (1994), Kasem and Somsak (1991) in cucumber and Pandey et al. (2002) in pumpkin also reported heterois for number of fruits.

High magnitude of heterosis for fruit yield was exhibited by the families 1, 2 and 3 in which the same female parents were used. Pyzhenkov and Kosareva (1979) in cucumber, Lavende and Patel (1990), Ram et al. (1997), Ranpise et al. (1992), Mishra et al. (1994), Ram et al. (1997), and Radhika, (1999) in snake gourd, Janakiram and Sirohi (2002), Sharma et al. (1995), Bhalala et al. (2002) and Dubey and Mourya (2002) in bottle gourd, Choudhary et al. (2002) in musk melon, Mandal and Sirohi (1993) in pumpkin, Sirohi (1993) and Pandey et al. (2002) in pumpkin, Ghai et al. (1998) in summersquash also reported heterosis for fruit yield. Superior hybrids obtained from this study can be multiplied vegetatively for the fixation of heterosis.

SUMMARY

6. SUMMARY

The present investigation on "Development and evaluation of hybrids in ivy gourd (*Coccinia grandis* L.Viogt.)" was carried out at the College of Agriculture, Vellayani during 2007-2008. The objectives of the study were to develop hybrids in ivy gourd, to estimate genetic parameters, variability among and within families and to identify superior hybrids over the check variety "Sulabha".

Hybridization was carried out between four genetically diverse gynoecious and three morphologically distinct androecious lines. Based on the mean values of the twelve families and their progenies, variability among the families and progenies were studied. Genetic parameters and standard heterosis were also estimated in this study.

The analysis of variance conducted for 12 F_1 families showed significant differences among the progenies for different characters. The mean values recorded for eight characters showed wide variation among the families. The family 1(Royappanpatty 1 x Royappanatty local) revealed superiority over the other families for days to first flower, first harvest, length, girth, number of fruits and fruit yield per plant.

The magnitude of variation among the progenies of 12 families revealed the heterogeneous nature of the F_1 families. The heterogeneous nature of the F_1 population along with the advantage of clonal propagation facilitates fixation of heterosis in the F_1. Significant variations among the progenies for vitamin C content was expressed in eight families viz., family 3 ,4, 5, 7, 9, 11 and 12. Seven families viz., family 2, 3, 4, 5, 6, 11 and 12 showed significant variations among progenies for days to first flowering. Variations among progenies for fruit length were expressed by the families 2, 3, 4, 6, 9, 10, and 11. The families 4, 5, 8 and 10 showed significant variations for average fruit girth among the progenies. The

families 4, 5 and 7 showed variations among progenies for days to first fruit harvest. The families 2, 6 and 8 showed variations among the progenies for girth of fruits. Families 4, 6 and 11 recorded significant variations among the progenies for number of fruits. Families 4 and 6 showed significant variations among progenies for fruit yield per plant. Superior plants can be selected from the families showing significant variation for different characters.

Pooled analysis of the data showed significant differences among the progenies for all the characters. The minimum days to flowering was recorded in progeny 1 and 5 of family 1 (Royappanpatty 1 x Royappanatty local) followed by progeny 7 of the same family and progeny 1 of family 3. (Royappanpatty 1 x Karyavattam). The maximum time for flowering and fruit harvest was taken by progeny 5 of family 12 (Karuvalur x Karyavattam). The progeny 1 of family 1 was found to be earliest to harvest followed by progenies 2, 5 and 6 of the same family.

Significant variation for average fruit length was observed among the progenies. Progeny 1 of family 1 recorded the longest fruits. The shortest fruits were produced by progeny 4 of family 4 (NBPGR x Royappanpatty local). The progeny 4 of family 4 (NBPGR x Royappanpatty local) also recorded the lowest value for fruit girth. The highest fruit girth was observed in progeny 1 of family 4. The progeny 3 of family 3 produced fruits having the maximum weight followed by progeny 3 of family 1. The maximum number of fruits were produced by progeny 4 of family 1 and the minimum was recorded by progeny 2 of family 6 (NBPGR x Karyavattam). Progeny 1 of family 4 recorded the highest vitamin C content and the lowest being in progeny 1 of family 5.

The highest fruit yield was recorded by progeny 3 of family 1 followed by progeny 1 of family 3 and progeny 3 of the same family. Most of the families were heterogeneous for different characters.

The analysis of variance revealed significant differences among the genotypes for all the characters studied viz., days to first flowering, days

to first fruit harvest, average length of fruits, average girth of fruits, average weight of fruits, number of fruits per plant, vitamin C content and fruit yield per plant.

The genetic parameters of different characters in 12 families of ivy gourd were estimated in this study. The differences between phenotypic and genotypic coefficient coefficients of variation for different characters were found to be low in this study indicating the major contribution of genetic component.

The highest heritability was estimated for days to first harvest followed by fruit yield per plant, fruit weight, fruit length, fruit girth, number of fruits per plant, days to first flower and vitamin c content. Heritability was generally high for all the characters in this study. High heritability and high genetic advance for important traits like fruit yield per plant, number of fruits per plant, and fruit weight indicated the effectiveness of selection.

The correlation analysis revealed significant positive correlation of number of fruits per plant with yield per plant, fruit length and fruit weight. Positive association of these characters indicated the possibility of simultaneous improvement by selection.

Number of fruits per plant as well as length, girth and weight of fruits exerted significant positive direct effect on fruit yield per plant. Therefore improvement of anyone of these characters would bring out simultaneous improvement of yield.

The families showed standard heterosis at varying levels for different characters. In this study mean values of the families were taken for comparison with the standard parent. Compared to the standard check variety "Sulabha" the hybrid population took more days to flower. However, among the hybrid progenies family 1 took the minimum days to flower and fruit harvest. The families 1 (Royappanpatty 1 x Royappanatty local) and 3 (Royappanpatty 1 x Karyavattam) manifested marginal

positive heterosis for fruit length and families 1 (Royappanpatty 1 x Royappanatty local), 2 (Royappanpatty 1 x Vellayani local), 3 (Royappanpatty 1 x Karyavattam) 5 (NBPGR 1 x Vellayani local and) and 6 (NBPGR x Karyavattam) expressed heterosis for fruit girth. The positive heterosis for average fruit weight was observed in the families 1 and 3.

The maximum positive heterosis for number of fruits per plant was observed in the family 1 followed by 2 and 3. Nine hybrids expressed positive heterosis for vitamin C content. The heterosis for fruit yield per plant was the maximum in family 1 followed by 3 and 2. The superior progenies identified for different characters from the hybrid population can be utilized for further improvement.

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*Original not seen

DEVELOPMENT AND EVALUATION OF HYBRIDS IN IVY GOURD (*Coccinia grandis* L.Voigt.)

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ABSTRACT

The present investigation on "Development and evaluation of hybrids in ivy gourd (*Coccinia grandis* L.Viogt.) was carried out at the College of Agriculture, Vellayani during 2007-2008. The objectives of the study were to develop hybrids in ivy gourd, to estimate genetic parameters, variability among and within families and to identify superior hybrids over the check variety "Sulabha".

Hybridization was carried out between four selected gynoecious and three androecious lines. Based on the mean values of the twelve families and their progenies variability among the families and progenies were studied. Genetic parameters and standard heterosis were also estimated in this study.

The family 1(Royappanpatty 1 x Royappanatty local) revealed superiority over the other families for days to flower, first harvest, length, girth number of fruits and fruit yield per plant.

The magnitude of variation among the progenies of 12 families revealed the heterogeneous nature of the F_1 families. Significant variation among the progenies for vitamin C content was expressed in eight families viz., family 3, 4, 5, 7, 9, 11 and 12. Seven families viz., family 2, 3, 4, 5, 6, 11 and 12 showed significant variations among progenies for days to first flowering. Variations among progenies for fruit length were expressed by the families 2, 3, 4, 6, 9, 10, and 11. The families 4, 5, 8 and 10 showed significant variations for average fruit girth among the progenies. The families 4, 5 and 7 showed variations among progenies for days to first fruit harvest. The families 2, 6 and 8 showed variations among the progenies for girth of fruits. Families 4, 6 and 11 recorded significant variations among the progenies for number of fruits. Families 4 and 6 showed significant variations among progenies for fruit yield per plant. Superior plants can be

selected from the families showing significant variation for different characters.

Pooled analysis of the data showed significant differences among the progenies for all the characters. The minimum days to flowering was recorded in progeny 1 and 5 of family 1 (Royappanpatty 1 x Royappanatty local) followed by progeny 7 of the same family and progeny 1 of family 3. (Royappanpatty 1 x Karyavattam). The same trend was observed for days to first harvest of fruits. The progeny 1 of family 1 was found to be earliest to take harvest followed by three other progenies progeny 2, 5 and 6 of the same family.

Significant variation for average fruit length was observed among the progenies. Progeny 1 of family 1 recorded the longest fruits. The highest fruit girth was observed in progeny 1 of family 4. The progeny 3 of family 3 produced fruits having the maximum weight followed by progeny 3 of family 1. The maximum number of fruits was produced by progeny 4 of family 1. Progeny 1 of family 4 recorded the highest vitamin C content. The highest fruit yield was recorded by progeny 3 of family 1 followed by progeny 1 of family 3 and progeny 3 of the same family. Superior progenies identified for different characters from the hybrid population can be utilized for further improvement.

The results of the analysis of variance showed significant differences among the genotypes for all the characters studied.

The differences between phenotypic and genotypic coefficients of variation were found to be low in this study indicating the major contribution of genetic component.

The highest heritability was estimated for days to first harvest followed by fruit yield per plant, fruit weight, fruit length, fruit girth, number of fruits per plant, days to first flower and vitamin c content. High heritability and high genetic advance estimated for important traits like fruit yield per plant, number of fruits per plant, and fruit weight which indicated the effectiveness of selection.

Higher genotypic correlation than the phenotypic correlation observed for most of the characters indicated the reduced influence of environment. The number of fruits per plant had significant positive correlation with yield per plant, fruit length and fruit weight. Average length of fruits, girth of fruits, average weight of fruits and number of fruits per plant exerted significant positive direct effect on fruit yield per plant. Therefore improvement of anyone of these characters would bring out simultaneous improvement of yield.

The families showed standard heterosis at varying levels for different characters. In this study mean values of the families were taken for comparison with the standard parent. Compared to the standard check "Sulabha" the hybrid population took more days to flower. However, among the hybrid progenies family 1 took the minimum days to flower and fruit harvest. The families 1 (Royappanpatty 1 x Royappanatty local) and 3 (Royappanpatty 1 x Karyavattam) manifested marginal positive heterosis for fruit length and families 1 (Royappanpatty 1 x Royappanatty local), 2 (Royappanpatty 1 x Vellayani local), 3 (Royappanpatty 1 x Karyavattam) 5 (NBPGR 1 x Vellayani local and) and 6 (NBPGR x Karyavattam) expressed heterosis for fruit girth. The positive heterosis for average fruit weight was observed in the families 1 and 3.

The maximum positive heterosis for number of fruits per plant was observed in the family 1 followed by 2 and 3. Nine hybrids expressed positive heterosis for vitamin C content. The heterosis for fruit yield per plant was the maximum in family 1 followed by 3 and 2. The superior progenies identified for different characters from the hybrid population can be utilized for further improvement.