GENETIC ANALYSIS
IN
IVYGOURD
(Coccinia grandis (L.) *Voigt.)*

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Vellayani, Thiruvananthapuram
Kerala

DECLARATION

I hereby declare that this thesis entitled **"Genetic analysis in ivygourd *(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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CERTIFICATE

Certified that this thesis entitled **"Genetic analysis in ivygourd *(Coccinia grandis* (L.) *Voigt.)"*** is a record of research work done independently by Shri Siby Varghese under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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INTRODUCTION

1. INTRODUCTION

Ivygourd (*Coccinia grandis* (L.) *Voigt.*) is a semiperennial, dioecious creeper widely cultivated in South East Asian countries. In India, 'Kowai fruit' as it is popularly known is a common vegetable grown extensively in West Bengal, Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra and Gujarat. In Kerala cultivation of ivygourd is still confined to kitchen gardens. In Kasargode and nearby places ivygourd is cultivated on commercial scale and farmers find it much profitable (Premnath and Subramoniam, 1971).

Ivygourd belongs to the family Cucurbitaceae and consists of male and female plants. (Veeraragavathatham *et al.,* 1998). Distinct sex forms in coccinia are due to the presence of characteristically distinct sex chromosomes. Gynodioecious forms consisting of female and hermaphrodite flowers have also been observed. Maleness is expressed by the influence of 'Y' chromosome. The crop is highly cross pollinated. Bose and Som (1985) reported that ivygourd gives yield for three to four years.

Ivygourd is profusely mentioned in the books of Ayurveda. Almost all parts of the plant are said to be of immense medicinal value. Kowai attained historic acclaim as we find it mentioned at many places in Vedas and Ithihasas – the ancient holy books of India. The nutritious value was assessed as high as that of goat's milk and mutton. Tender fruits of ivygourd are rich in protein content

(1.2%) (Sachan and Chundawat, 1985). Presence of 260 IU of Vitamin A and 28 mg. of Vitamin C per 100 g. of the fruit was also reported. Veeraragavathatham *et al.* (1998) found that the tender fruits and shoots of ivygourd are eaten raw or cooked while roots, stem and leaves are used as ingredients of medicines for the treatment of skin diseases, bronchitis and diabetes. The main marketed vegetables in Kerala constitute only 20 species. But about 60 species are grown in smaller areas strictly for household uses. Ivygourd is one among them. (Indira and Peter, 1988).

Breeding attempts on ivygourd have been rare. The main reason for this may be ascribed to the constraints such as the dioecious and semiperennial nature of plants and occurrence of parthenocarpy. No high yielding variety has been identified so far. A local type known as "Padappai" cultivated in Chengalpattu district in Tamil Nadu is reported to be a prolific bearer of sweet, soft fruits (Veeraragavathatham *et al.*, 1998).

In any breeding programme success depends on the availability of genetic variation in a population. This aim in view, it has been considered necessary to collect and correlate informations on genetic parameters like phenotypic coefficient of variation, genotypic coefficient of variation, heritability and expected genetic advance for yield and yield related characters. Since ivygourd is dioecious the present study is conducted on a large collection of female lines interspaced with 10 per cent male plants to ensure pollination.

Development of high yielding varieties of ivygourd is necessary to inspire the interest of farmers and enthuse them to promote large-scale cultivation. As a preliminary and essential step in this direction, the present programme of observation and study was taken up to evaluate and assess the genetic basis and variability for different characters in the available germplasm and to find out the direct and indirect components of yield. Superior varieties were identified through discriminant function analysis and genetic clusters were identified through D^2 analysis. This identification and findings are only spade works which would certainly aid further breeding efforts.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Ivygourd is a semiperennial vegetable gourd, which is popularly grown in West Bengal, Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra and Gujarat. In Kerala, it still remains as an under exploited vegetable crop. No high yielding variety is reported in this crop so far. Breeding work in ivygourd is very much limited. It is due to the constraints like dioecious nature of plants, semi perennial habit and occurrence of parthenocarpy.

Crop improvement programmes of cucurbitaceous vegetables were dragged on for more than half a century but some achievement has been made only in improved cultural practices and in the incorporation of better levels of disease resistance. For any crop improvement programme, it is necessary to collect information on genetic variability, correlation of variables, heritability, genetic advance, path coefficient, genetic diversity etc. On this basis, a selection index is generally prepared. The information on ivygourd is found scarce and scanty. Literature available on other cucurbitaceous vegetables is relevant for an in-depth study of ivygourd as well and hence reviewed here under different heads.

2.1 Genetic Parameters

Important methods used for improvement of any crop depend a great extent on selection. An insight into the magnitude of variability present in a crop species is of utmost importance as it provides the basis for effective selection.

The selection is effective only when major part of the variability is genetic. Unraveling the hitherto unknown variability present in any crop species is very important to make selection apt and effective. Variability in a population could be partitioned into heritable and non-heritable components with the aid of genetic parameters such as phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and genetic advance (GA), which serves as a basis for selection (Johnson *et al.,* 1955).

2.1.1. Variability and Coefficient of Variation

In ivygourd Raju and Peter (1995) reported considerable variability in fruit length, fruit weight and fruit size. Joseph (1999) observed a wide range of variation for number of days for first flower opening, fruit length, average fruit weight, number of fruits per plant and fruit yield per plant. The GCV and PCV were high for primary branches per plant and fruit yield per plant.

In cucumber Smith *et al.* (1978) studied several cucumber populations and observed additive variance was important in phenotypic variation. The result indicated genetic variability for yield is sufficient to achieve the progress.

Solanki and Seth (1980) observed a wide range of variation among 24 genotypes of cucumber for plant height, leaves per plant, leaf area, internode length, male flowers per plant, days to first flower opening, female flowers per plant, fruits per plant and yield per plant.

Choudhary and Mandal (1987) reported significant genotypic variance for several yield components in cucumber. Genetic variance for secondary branches per vine, yield per vine, primary branches per vine, vine length and fruits per vine is probably due to high additive gene effect. Owens *et al.* (1985) recorded significant genetic variability among several lines within a population of cucumber genotypes for fruit size and weight.

Prassunna and Rao (1988) reported high degree of both phenotypic and genotypic variation for female flowers per vine, percentage of fruit set, fruits per vine and yield per vine in a collection of cucumber genotypes indicating high genetic variability. They also observed that the GCV ranged from 5.14 to 73.35 per cent while the PCV ranged from 8.52 to 80.13 per cent in a collection of cucumber genotypes.

Abusaleha and Dutta (1990) examined 75 pure genotypes of cucumber and observed high degree of genotypic and phenotypic variance for number of branches per plant, leaf area, number of leaves per plant, root: shoot ratio and yield per plant. Mariappan and Pappiah (1990) studied 45 diverse cucumber genotypes and reported a wide range of variation for all traits except number of leaves per plant. The PCV was the highest for seeds per fruit followed by weight of seeds per fruit. The difference between PCV and GCV was invariably low for all the characters indicating less environmental influence on the expression of these characters. Rastogi and Deep (1990 a and b) recorded higher PCV and GCV for fruit yield per plant and fruit weight. PCV and GCV were minimum for days to first flower opening. The magnitude of genotypic variation nearly approached phenotypic variation in majority of characters.

Satyanarayana (1991) observed a wide range of variability among 22 cucumber accessions for all the characters excluding branches per vine and flesh thickness. This was confirmed by the wide range of phenotypic and genotypic coefficients of variation observed for all the characters. Prasad and Singh (1992) studied 23 genotypes of cucumber and observed wide range of genetic variation for number of branches per vine, number of leaves, leaf area and root : shoot ratio. Prasad and Singh (1994 a) found that among six monoecious lines of cucumber, yield and its ten components showed significant genetic variance.

From an observational trial among six slicing cucumber cultivars considerable variance was found in respect of yield and earliness, Anon (1996). Wehner and Cramer (1996) reported genetic variance for total, early and marketable fruits per plot, fruit shape, fruit size and fruit weight in three slicing cucumber populations. 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 in cucumber.

In bittergourd Srivastava and Srivastava (1976) conducted studies with 10 lines and observed significant differences for all the characters except for number of flowers per plant. The highest GCV was for fruits per plant (37.45 per cent) followed by yield per plant (32.13 per cent) and fruit weight (30.02 per cent). The lowest GCV (11.47 per cent) was observed for number of flowers per plant.

Singh *et al.* (1977) reported significant differences among the bittergourd varieties for yield per plant, fruits per plant, fruit weight, days to flowering and number of flowers per plant in a study of 25 lines. The yield and its main components, fruits per plant and fruit length showed high GCV (35 per cent, 39 per cent and 34 per cent respectively) while days to flower showed the lowest GCV (4 per cent).

Ramachandran and Gopalakrishnan (1979) evaluated 25 types of bittergourd and observed significant variability for primary branches per plant, main vine length, node to first female flower, days to first female flower opening, number of female flowers, days to picking maturity, yield per plant, number weight and size of fruits, seeds per fruit and 100 seed weight. They observed highest PCV (39.88 per cent) and GCV (37.82 per cent) for yield per plant. The lowest GCV was observed for seeds per fruit. Ramachandran and Gopalakrishnan (1980) observed significant variability with respect to certain biochemical traits in bittergourd such as protein content, vitamin A and vitamin C content in fruits.

Mangal *et al.* (1981) conducted studies on 21 varieties of bittergourd and observed significant variation for all the characters. The highest GCV was shown by yield per plant and the lowest by days to first female flower opening. Indiresh (1982) studied 24 lines and observed high GCV for fresh fruit weight, yield per plant and fruit size. Suribabu *et al.* (1986) analysed six lines of bittergourd and found GCV was moderate to high for all the characters except number of fruits per plant and percentage fruit set.

Choudhary (1987) reported significant variability in respect of various vegetative and yield characters of different bittergourd varieties. The highest PCV and GCV were noticed for yield per plant, fruits per plant, vine length and fruit weight. However, PCV and GCV were low for early female flower formation and early harvest.

Vahab (1989) while studying genetic variability in 50 genotypes of bittergourd observed significant differences for 18 characters. The highest PCV was observed for fruit weight, 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, weight, contents of protein, carbohydrates, vitamin A, vitamin C, acidity and total phenol. They reported considerable variation for these traits. Thakur *et al.* (1994) studied mean square estimate for genotypes of bittergourd and reported significant variability for vine length, number of branches per plant, root : shoot ratio and number of flowers per plant.

Katiyar *et al.* (1996) reported that all the characters in bittergourd showed variation in various genetic parameters. The phenotypic coefficient of variation (PCV) was maximum for yield per plant followed by length of main vine. Genotypic coefficient of variation was minimum for number of female flowers and maximum for yield per plant. Iswaraprasad (2000) observed highest PCV and GCV for fruit yield per plant followed by mean weight of fruit, fruit size and seeds per fruit in bittergourd.

In ridgegourd Reddy and Rao (1984) found that PCV ranged from 14.38 to 162.62 per cent and GCV from 13.56 to 112.03 per cent for days to first marketable fruit formation and yield per plant respectively.

Prasad and Singh (1989) reported variability in 11 genotypes. Four characters viz., number of fruits, fruit size, yield per plant and yield in quintals per hectare exhibited highly significant differences among the genotypes. The characters vine length, node number, node on which the first flower appeared and fruit diameter did not show any significant difference. High GCV and PCV for the characters like yield per plant, yield in quintals per hectare and number of fruits indicate that maximum amount of variability existed in the genotypes for these characters.

Varalakshmi *et al.* (1995) reported high PCV and GCV for fruits per plant, fruit weight, seeds per fruit and yield per plant. Khanikar *et al.* (1996) reported significant genotypic variability for characters relating to growth, maturity and fruit yield in ridgegourd. Variability studies in ridgegourd revealed significant differences for vine length, primary branches, internodal length, days to first female flower, nodes to first female flower, root : shoot ratio, days to first harvest, fruits per plant, yield per plant, average fruit weight, fruit size, seeds per fruit and crop duration (Anitha, 1998).

In bottlegourd Tyagi (1972) conducted variability studies with 5 inbreds and significant differences were noticed among the strains in respect of all the characters. Fruits per plant had the highest GCV (48.26 per cent) followed by seed breadth (31.96 per cent), fruit length (26.64 per cent) and fruit size (23.28 per cent).

Rahman *et al.* (1994) conducted biochemical studies and observed considerable variability for nitrogen content, phosphorous, potassium, chlorophyll a and b, carotenoids, sucrose and maltose in the leaves of different types of bottlegourd. The protein, vitamin A and C and starch content of fruits were also varied.

Kumar *et al.* (1999) noticed maximum GCV for number of fruits per plant followed by fruit yield per plant. Mathew (1999) found in bottlegourd significant differences for vine length, primary branches, days to first primary branches, days to first female flower opening, root : shoot ratio, sex ratio, fruits per plant, fruit yield per plant, fruit size, 100 seed weight, seeds per fruit and crude fibre content. Bisognin and Storck (2000) reported significant estimates for genetic variance for large fruit diameter and neck diameter in bottlegourd.

In snakegourd, Joseph (1978) reported highest GCV for fruit weight (28.29 per cent) and fruit length (29.81 per cent). Pynadath (1978) studied genetic variability in a collection of 25 genotypes of snakegourd. High variation was observed for days to first male and female flower anthesis, fruits per plant, yield per plant, fruit size and weight, flesh thickness, seeds per fruit and 100 seed weight. Highest GCV was reported for fruit weight. GCV was higher for fruit size also.

Varghese (1991) found high variation among 48 genotypes of snakegourd for days to first female flower, fruit harvest, yield per plant, number of fruits and seeds per fruit. Highest PCV and GCV were recorded for number of flowers per plant and lowest PCV and GCV were recorded for number of days for first flowering. Varghese and Rajan (1993) found GCV was high for fruiting nodes on main vine, flowers per plant, root : shoot ratio, fruits per plant and crude fibre content in snakegourd. Mathew (1999) reported the highest PCV and GCV for mean weight of fruit and the lowest PCV and GCV for flesh thickness.

Radhika (1999) found that in snakegourd the PCV values ranged from 5.63 to 21.83 per cent. PCV for flesh thickness was the highest. It was followed by fruit yield per plant and number of fruits per plant. The GCV values ranged from 4.22 per cent (days to first fruit harvest) to 21.54 per cent (flesh thickness). Fruit yield per plant and number of fruits per plant also had high values of GCV. Ashok (2000) found wide variation in seed, growth and yield characters in a study of character association of seeds with plant morphology in snakegourd.

In pointedgourd Singh *et al.* (1986) reported high GCV for yield per plant, fruit size and fruits per plant. Sarkar *et al.* (1990) observed high genotypic and phenotypic variances for fruits per plant fruit volume and number of seeds per fruit. Singh *et al.* (1992) reported significant differences for leaf area, number of leaves per plant, number of flowers per plant, number of fruits per plant and yield in pointedgourd. High GCV was observed for yield and number of fruits.

In spongegourd Arora *et al.* (1983) reported maximum range of variation and high GCV and PCV for yield per plant. For fruits per plant and sex ratio also GCV and PCV were high.

In ashgourd George (1981) conducted biochemical studies and reported significant difference for protein content in fruits, vitamin C in fruits, fruit yield, length of main vine, female flowers per plant, average fruit weight, weight of first mature fruit, number of fruits per plant, leaves per plant, fruit size, flesh thickness, seeds per fruit and 100 seed weight. Variability was limited for days to first female flower anthesis.

Hamid *et al.* (1989) observed a vide range of variability for number of flowers per plant, number of fruits per plant, fruit weight and fruit size in a collection of ashgourd. Menon (1998) conducted a study for cataloging and identifying of promising ashgourd ecotypes in relation to season and maturity. Maximum GCV was observed for primary branches per plant followed by fruit yield per plant.

In pumpkin Gopalakrishnan (1979) studied 18 genotypes and it was found that the genetic variability was significant for all the 25 quantitative characters studied. Maximum value of GCV was observed for flowers per plant followed by fruits per plant.

Diojode and Sulladmath (1986) reported high PCV and GCV for fruit weight and β carotene content as compared to other characters in pumpkin. Rana *et al.* (1986) while studying genetic variability on yield and 11 yield related quality and development traits in pumpkin, found highly significant differences for all traits excluding dry matter and carotenoid content. The PCV and GCV were high for vine length, number of fruits per plant, branches per plant and fruit weight.

In pumpkin Sureshbabu (1989) observed highest GCV for seeds per fruit (37.37 per cent) and the lowest for node at which the first female flower is formed (12.77 per cent). The highest and lowest PCV were observed for yield per plant (58 per cent) and days to first flower anthesis (13.08 per cent) respectively.

Borthakur and Shadeque (1990) reported high genotypic and phenotypic variances for main creeper length, leaves per plant and fruit size index in pumpkin.

Sirohi (1994) observed in pumpkin significant variation with wide range for number of leaves per plant, number of flowers per plant, total number of fruits and fruit yield per plant. Kumaran *et al.* (1997) observed that the estimates of GCV were smaller than the estimates of PCV for most of the traits studied in pumpkin. However, GCV was high for mean fruit weight, number of fruits per plant, number of seeds per fruit and yield per plant. Mohanty and Mishra (1999) observed high GCV and PCV for yield and number of fruits per plant in pumpkin. PCV was greater than GCV for all the traits.

In watermelon Thakur and Nandpuri (1974) observed variability for vine length, branches per plant, sex ratio, days to flower opening, fruits per vine, average fruit weight, yield per vine, seeds per fruit, 100 seed weight, and total soluble solids. The PCV was maximum for seeds per fruit (41.31 per cent) and minimum for days to flower opening (6.46 per cent). The GCV value also showed the same trend.

Prasad *et al.* (1988) reported high PCV and GCV for fruits per plant, average fruit weight, seeds per fruit, 100 seed weight and fruit yield per plant. Hegde *et al.* (1994) found that among the varieties of watermelon cultivated in paddy fallows of Malanad, Kerala considerable variation was found for the yield and yield related characters.

Rajendran and Thamburaj (1994) found considerable variation for the various yield and yield related characters in watermelon. High PCV and GCV were recorded for average fruit weight, seeds per fruit, 100 seed weight and fruit yield per plant. Shibukumar (1995) noted significant differences for all the characters in the variability studies in 20 genotypes of watermelon. High PCV and GCV were reported for number of seeds per fruit, number of fruits per plant and node to first female flower.

In muskmelon Kalyanasundaram (1976) reported significant differences among three varieties for economic characters such as number of fruits per plant, fruit weight, fruit size and yield per plant. Swamy *et al.* (1985) observed maximum PCV and GCV for marketable yield per plant. It was followed by total yield per plant and average fruit weight.

Chacko (1992) noticed moderate to high GCV for yield per plant in a study for evaluation of desert type muskmelon. Genotypic differences among the cultivars were the primary source of variation.

Ram *et al.* (1996) evaluated germ plasm of various cucurbits, including pumpkin, watermelon, cucumber, bottlegourd, bittergourd and muskmelon. High variability was shown for days to first male flower, days to first female flower, nodes to first male or female flower, vine length, primary laterals, nodes on main vine, fruits per plant and fruit length, breadth and weight.

2.1.2 Heritability and Genetic Advance

In the process of crop improvement only the genetic component is transmitted to the subsequent generations. The extent of improvement further depends on the intensity of selection and genetic advance obtained from the population. High heritability is not always an indication of high genetic advance (Johnson *et al.,* 1955).

In ivygourd, Joseph (1999) observed high heritability for vine length primary branches per plant, fruit yield per plant and number of fruits per vine.

In snakegourd Pynadath (1978) observed highest value for heritability for fruit length and it was followed by fruit girth. Yield per plant recorded a comparatively low estimate of heritability while the lowest value was recorded by fruits per plant.

Varghese (1991) noticed in snakegourd high heritability coupled with high genetic gain for flowers per plant, sex ratio and number of branches on the main vine.

Varghese and Rajan (1993) observed high magnitude of both heritability and genetic advance for fruits per plant, while yield per plant, fruit length, crop duration, days to first harvest and days to first male flower opening showed high heritability coupled with low genetic gain. Mathew and Khader (1999) reported mean fruit weight, seeds per fruit, fruit length and fruit yield per plant had high heritability coupled with high genetic advance.

Radhika (1999) reported the highest and 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 male flower opening, days to first female flower opening, fruit length, fruit yield per plant, flesh thickness, number of fruits per plant and 100 seed weight.

In bottlegourd Prasad and Prasad (1979) reported high heritability coupled with high genetic advance for fruit length and fruit diameter. Sirohi *et al.* (1986) recorded high narrow sense heritability for days to first male and female flower opening, fruit length, girth and weight and fruits per plant. Sharma and Dhankar (1990) reported high heritability coupled with high genetic advance for fruits per plant.

Kumar *et al.* (1999) observed high heritability for all the characters studied and high genetic advance was recorded for fruit yield per plant. It was followed by number of fruits per plant and number of branches per plant.

Mathew (1999) reported high heritability and genetic advance for vine length, primary branches, node to first female flower, fruit length, fruit girth and seeds per fruit in bottlegourd. Bisognin and Storck (2000) observed moderate heritability for fruit shape in bottlegourd.

In pointedgourd Singh *et al.* (1986) observed high heritability with high expected genetic advance for fruits per plant and yield per plant.

Sarkar *et al.* (1990) in a study with 16 divergent genotypes of pointedgourd found that fruit diameter had high heritability and low genetic advance.

Singh *et al.* (1992) found that in pointedgourd all characters were highly heritable. High heritability with high expected genetic advance was seen for fruits and yield per plant.

In ridgegourd Reddy and Rao (1984) recorded highest heritability for average fruit weight and lowest heritability for days to first harvest. High heritability coupled with high magnitude of genetic gain was recorded for yield, individual fruit weight, number of fruits and fruit length. Kadam and Kale (1987) reported high heritability and genetic advance for days to flowering.

Prasad and Singh (1989) noticed high heritability and low genetic advance in ridgegourd for number of nodes, node on which the first female flower appeared, fruit length and fruit diameter. These were attributable to the non-additive effects. High heritability coupled with high genetic advance was noticed for yield in quintals per hectare, yield per plant and number of fruits. Low heritability was recorded for vine length, followed by fruit diameter, number of nodes and node on which the first female flower appeared. The same observation was made in another collection of cucumber by Prasad and Singh (1994 b).

Varalakshmi *et al.* (1995) observed high heritability values for seeds per fruit, fruit weight, days to first female and male flower, fruit length, 100 seed weight and fruits per plant and low heritability for number of branches per plant and fruit diameter. Seeds per fruit and 100 seed weight showed high estimates of heritability and genetic advance.

Anitha (1998) recorded in ridgegourd high heritability along with high genetic advance for vine length, sex ratio, fruits per plant, yield per plant, fruit size and seeds per fruit. Days to first female flower opening and days to harvest had highest heritability but low genetic advance.

In spongegourd, Arora *et al.* (1983) reported high estimates of heritability and genetic advance for yield per plant and fruits per plant.

Prasad *et al.* (1984) found that yield per plant and four other traits gave heritability estimates of 100 per cent. High values for both heritability and genetic advance were obtained for five traits including fruit size and diameter.

In pumpkin, Rana *et al.* (1986) reported high heritability associated with high genetic gain for number of flowers and fruit number. Singh *et al.* (1988) and Borthakur and Shadeque (1990) reported high heritability associated with high genetic gain for fruit weight. Fruit weight recorded high values of heritability and genetic advance.

Sureshbabu (1989) reported high genetic gain for seeds per fruit (73.05 per cent) Yield had low heritability while seeds per fruit recorded the highest genetic advance. Kumaran *et al.* (1997) observed high heritability coupled with high genetic advance for vine length, mean fruit weight, fruits per plant, seeds per fruit and fruit yield per plant in pumpkin.

Mohanty and Mishra (1999) observed moderate heritability with moderately high genetic advance for yield per plant in pumpkin. Days to first anthesis, first female flowering node, flesh thickness, vine length and flowers per plant showed moderate to high heritability accompanied by low genetic advance.

In cucumber, Solanki and Seth (1980) noticed high heritability and low expected genetic advance for average fruit weight and number of fruits per plant.

Choudhary and Mandal (1987) reported high heritability and high genetic advance for yield per vine, branches per vine, vine length and fruits per vine. High heritability and low genetic advance were recorded for days to first female flower appearance, flowers per vine and fruit length indicated non-additive gene effects.

Owens *et al.* (1985) recorded that among several lines within a population of cucumber genotypes heritability was moderately high (0.8) for fruit size and intermediate (0.6) for fruit weight.

Abusaleha and Dutta (1990) noticed high heritability coupled with high genetic advance for fruit length in cucumber. Mariappan and Pappiah (1990) reported high heritability values for fruit length and girth, days to first staminate flower, number of seeds per fruit and fruit weight.

Rastogi and Deep (1990 a and b) recorded high heritability for yield per plant, days to fruit maturity, fruits per vine and fruit weight. Despite high heritability, certain other characters such as vine length, primary branches per plant, flowers per plant and days to flower had only moderate to low genetic gain.

Satyanarayana (1991) studied 22 cucumber accessions and reported high heritability and genetic advance for fruit yield per vine, number of flowers per plant and number of fruits per vine.

Prasad and Singh (1992) studied 23 genotypes of cucumber and observed 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 genetic advance was also observed for fruit length, fruit breadth and fruit weight indicating the action of additive genes for the expression of these characters.

Prasad and Singh (1994 b) reported high heritability and genetic advance for more than 12 growth and yield attributes in a collection of cucumber. Wehner and Cramer (1996) reported low and moderate heritability for fruit yield and number of days to flower.

Gayathri (1997) reported high heritability along with high genetic advance for yield per plant, fruits per plant, average fruit weight and days to first female flower.

In bittergourd Srivastava and Srivastava (1976) observed the highest heritability (99.31 per cent) and genetic advance (71.75 per cent) for fruits per plant and the lowest heritability (49.93 per cent) and genetic advance (16.73 per cent) for male flowers per plant.

Singh *et al.* (1977) reported high heritability for yield (92 per cent), fruits per plant (93 per cent) and fruit size (95 per cent). The expected genetic advance recorded for these characters were 69, 76 and 68 per cent respectively. The lowest heritability (22 per cent) and genetic advance (3.52 per cent) were observed for days to flower.

Ramachandran (1978) reported high estimates of heritability and genetic advance for yield per plant. Ramachandran and Gopalakrishnan (1979) reported the highest heritability of 99.80 per cent for fruits per plant and the highest genetic advance of 81.90 per cent for yield per plant.

Ramachandran and Gopalakrishnan (1980) noticed high or moderate estimates of heritability and high genetic gain for vitamin C, vitamin A, Protein, total soluble solids and iron contents. Mangal *et al.* (1981) observed high heritability values for leaf area, plant height, average fruit weight, branches, fruits, yield per plant and seeds per fruit.

Indiresh (1982) reported high heritability values for all the characters except yield per plant and days for fruit development in bittergourd.
Suribabu *et al.* (1986) noticed moderate to high genetic advance for seeds per fruit, days to first female flower and yield per plant.

Choudhary (1987) observed very high genetic advance for yield per plant, vine length, number of leaves per plant, number of flowers and number of fruits per plant. Vahab (1989) observed high heritability coupled with high genetic gain for fruit weight, yield and fruits per plant in bittergourd. Choudhary *et al.* (1991) also reported high estimates of heritability and genetic advance for yield per plant and number of fruits per plant. Rajput *et al.* (1996) reported high heritability in bittergourd for almost all the yield and related characters such as number of fruits per plant, single fruit weight and fruit size.

Iswaraprasad (2000) recorded high heritability for days to first male flower, days to first female flower, days to first fruit harvest, female flowers per plant, fruits per plant, mean weight of fruit, fruit yield per plant, fruit size, flesh thickness, seeds per fruit, 100 seed weight and crop duration in a study using 7 parents and 21 hybrids of bittergourd. All characters excluding days to first fruit harvest and crop duration showed high estimates of genetic advance.

In watermelon, Prasad *et al.* (1988) reported high heritability estimates for all the characters studied excluding days to first picking and branches per plant.

Rajendran and Thamburaj (1994) observed high heritability estimates for 100 seed weight, average fruit weight, yield per vine and number of seeds per fruit.

Gopal *et al.* (1996) reported high heritability accompanied by high genetic advance for length of vine and number of branches in watermelon. Deepthy (2000) observed high heritability and genetic advance for keeping quality, yield per plant, seeds per fruit, 100 seed weight, mean fruit weight, flowers per plant, fruits per plant, productive branches per plant and sex ratio in melon. High heritability and genetic advance were seen for days to first male flower opening, fruit diameter, flesh thickness, fruiting period and crop duration.

In muskmelon, Chonkar *et al.* (1979) reported that the values of heritability and genetic advance showed effectiveness in selection for fruit yield, single fruit weight and percentage of total soluble solids. Kalloo *et al.* (1981) observed high heritability estimates for fruit size, fruit weight, yield and number of fruits. High heritability coupled with high genetic gain was noticed for yield per vine, fruits per plant and fruit weight.

Swamy *et al.* (1985) reported moderate to high heritability estimates for all the characters studied. High heritability along with high genetic gain was observed for yield per vine and fruit weight, while high heritability with low genetic gain was noticed for days to flower opening.

Vijay (1987) noticed high heritability and high genetic advance for fruits per vine, total soluble solids, flesh thickness, yield per vine, fruit weight and days to flower in muskmelon. Chacko (1992) evaluated desert type muskmelon for southern region of Kerala. He observed association of high heritability with high genetic advance for yield per vine.

In ashgourd, Menon (1998) observed high heritability for seeds per fruit and size of fruits in a study for cataloguing and identification of promising ecotypes. Primary branches per plant had the highest genetic advance. High heritability and high genetic advance was seen for primary branches per plant, fruit yield per plant, seeds per fruit and average fruit weight.

2.2 Correlation Studies

Yield is the most important criterion of selection. Complexity of this character made up of several other component characters essentially make it the subject of a distinct study. Correlation studies would facilitate effective selection for improvement of one or many yield contributing components. An estimate of inter-relationship of yield with other traits is of immense help in any crop improvement programme.

In ivygourd, Joseph (1999) observed that fruits per plant, average fruit weight, fruit girth and fruit length showed significant positive correlation with yield. Fruits per plant had the highest correlation with yield. Sarnaik *et al.* (1999) reported that yield per plant showed positive and significant correlation with fruits per plant and size of fruits at genotypic and phenotypic levels in ivygourd. The yield was also significantly and positively correlated with vine length and number of branches at genotypic level.

In cucumber, Smith *et al.* (1978) measured a genotypic correlation of 1.01 and phenotypic correlation of 0.78 between fruit number and yield.

Choudhary and Mandal (1987) observed in thirty diverse genotypes of cucumber high positive correlation at the genetypic and phenotypic levels between yield per plant and number of fruits, female flowers per plant, fruit size and fruit weight. These characters along with fruit diameter were the most important characters determining yield.

Abusaleha and Dutta (1988) recorded association of yield with fruit size and flesh thickness to be positive and that with days to first male and female flowers to be negative in cucumber. Prassunna and Rao (1988) observed positive correlation of fruit yield with node to first female flower, days to first female flower opening, female flowers per vine, sex ratio, fruits per vine, average fruit weight and primary branches per vine.

Rastogi and Deep (1990 a) in a study of 25 cucumber cultivars revealed positive correlation of total yield per plant with fruits per plant, fruit weight and fruit size. Satyanarayana (1991) reported a positive correlation of yield with vine length, branches per vine, number of flowers per vine and total fruits per vine and a negative correlation with days to flower and percentage of deshaped fruits. Seed maturity was positively correlated with flesh thickness.

Rajput *et al.* (1991) recorded significant positive correlation between number of fruits and yield, and number of branches and yield in cucumber. Milotary *et al.* (1991) observed high correlation between number of seeds per fruit and fruit weight and fruit size in short fruited lines of cucumber, but these traits were poorly correlated in the slicing lines.

Prasad and Singh (1992) conducted correlation studies in cucumber and observed a significant and positive correlation of yield per plot with vine length, fruit size, fruit weight, flesh thickness and placental thickness. Chen *et al.* (1994) found that there was a significant positive genotypic correlation between number of flowers, number of parthenocarpic fruits and yield and between parthenocarpic fruit yield, number of fruits and average single fruit weight in cucumber.

Ma *et al.* (1995) reported that in cucumber total yield had a significant positive correlation with total fruit number, fruit size and average fruit weight. Number of branches and plant height also had an effect on total yield. Neikov *et* *al.* (1995) carried out correlation studies in salad cucumber and reported that yield was significantly correlated with number of flowers per plant fruit number and weight.

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. Saika *et al.* (1995) showed that yield per plant had strong positive correlation with main vine length, number of branches, single leaf area, number of leaves, fruiting percentage, fruits per plant, fruit weight and fruit size both at genotypic and phenotypic levels.

Gayathri (1997) reported that fruits per plant, average fruit weight, fruit size and fruit diameter were highly correlated with yield in cucumber. Zhang *et al.* (1999) reported that the three traits with the largest direct positive action on early yield were average fruit weight, harvested fruits per plant and average fruit length in cucumber.

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

In bittergourd Sidhu and Brar (1981) reported that yield was highly correlated with length of main vine, fruit weight, fruit size, number of fruits per plant, number of female flowers per plant and number of primary branches per plant. Number of seeds per kilogram of flesh showed negative correlation with yield.

Lawande and Patil (1989) reported that yield per plant was positively correlated with fruit weight and fruits per plant in bittergourd. Rajput *et al.* (1995) in correlation and path analysis studies on 21 genotypes of bittergourd indicated that fruit yield per vine was positively correlated with number of flowers, fruits per vine, average fruit weight, fruit length, percentage fruit set, vine length, number of leaves and leaf area. Fruit yield per vine was negatively correlated with days to first flower opening both at genotypic and phenotypic levels.

In ashgourd, George (1981) found that yield per plant was significantly and positively correlated with length of main vine, female flowers per plant, average fruit weight and weight of first mature fruit. The average fruit weight had the maximum direct effect followed by vine length. Significant negative correlation was seen between yield and number of days for first flowering

Menon (1998) observed that the fruits per plant had the highest positive and significant phenotypic correlation with yield in ashgourd. Highest genotypic correlation of yield was found with female flowers per plant. Yield was positively and significantly correlated with length of main vine, primary branches per plant, nodes on main vine, internode length, leaves per plant, female flowers per plant, percentage of female flowers, average fruit weight, fruits per plant, percentage of fruit set, circumference of fruit, fruit size and number of seeds per fruit.

Singh and Singh (1988) reported positive correlation of yield with fruits per vine and fruit weight. Rajendran and Thamburaj (1993) reported that average fruit weight was positively correlated with fruits per vine in watermelon.

Shibukumar (1995) reported that yield per plant recorded high positive genotypic and phenotypic correlation with fruits per plant, branches per plant, weight of individual fruit, fruit size and number of leaves per vine in water melon. Negative correlation was seen for yield per plant with length of vine, node to first fruit produced and days to first flower opening.

Dhaliwal *et al.* (1996) observed that fruit yield was positively correlated with fruit weight, fruits per vine and flesh thickness in muskmelon. Fruit weight and fruits per vine were negatively correlated. Gopal *et al.* (1996) recorded positive and significant correlations of branches per vine and female flowers per vine with yield in watermelon.

Gwanama *et al.* (1998) reported mid season traits (length of internodes with first female flower, length of primary axis, primary branches and leaves per plant) exhibited insignificant genotypic and phenotypic correlation with fruit yield in muskmelon. Late season traits (weight of first mature fruit and fruits per plant) had insignificant genotypic correlation on fruit yield.

In pointedgourd Prasad and Singh (1990) observed positive association of yield with fruit numbers and seed numbers and negative correlation with days to first flowering and picking. Singh *et al.* (1993) reported that high yield was positively correlated with number of fruits per plant in pointedgourd. Fruits per plant, days to first flowering and average fruit weight were responsible for yield increase.

Sarkar *et al.* (1999) conducted correlation studies in pointedgourd and reported that fruit weight, fruit size and number of primary branches per plant were positively and significantly correlated with yield per plant at genotypic and phenotypic levels.

In ridgegourd, Kadam *et al.* (1992) found positive correlation of yield with fruits per plant and fruit weight. Anitha (1998) reported that vine length, primary branches, internodal length, days to first female flower, node to first female flower, days to harvest, fruit set, fruits per plant, average fruit weight and average fruit size had significant positive correlations with yield in ridgegourd.

Rao *et al.* (2000) reported that in ridgegourd yield per vine was significantly and positively associated with fruit girth, weight and volume of fruits, fruits per vine, branches per vine and fruits per branch. Negative association was observed with days and node of first female flower.

Borthakur and Shadeque (1990) reported that length of main creeper, leaves per plant, flower per plant, fruits per plant, fruit weight and fruit size index have direct influence on yield.

Kumar *et al.* (1999) reported positive and significant correlations for days to first female flower, vine length, mean fruit weight, fruits per plant and seeds per fruit with fruit yield per plant in pumpkin. Devadas *et al.* (1999) observed that total number of seeds per fruit and 100 seed weight were the greatest in big fruits. Fruit weight was significantly correlated with polar and equatorial diameter, total number and number of seeds per fruit and 100 seed weight.

2.3 Path Co-efficient Analysis

Different character traits and the causes of their association either direct or indirect are analysed for an in-depth understanding of the relative importance of each factor.

In snakegournd, Pynadath (1978) noted that yield per plant was highly associated with number of branches per plant, days to first flower, fruit weight and size. Fruit weight, fruit girth and number of fruits are the important characters contributing to yield on account of their high direct effects. Female flowers, leaf area and vine length are also important with moderate direct effects and substantial indirect effects.

In bittergourd, Ramachandran (1978) reported that fruit weight, fruits per plant and length of main vine had high direct positive effects on yield. Number of branches per plant, female flowers per plant and fruit length had negative direct effects on fruit yield.

Gopalakrishnan *et al.* (1980) examined 25 quantitative characters in 18 genetically distinct types of pumpkin. Main stem length and average fruit weight proved to have the greatest direct effects on yield.

Prassunna and Rao (1988) conducted path co-efficient analysis in cucumber and recorded that fruits per vine and average fruit weight were the important yield contributing factors. A significant positive effect was found between fruits per vine and yield, branches per vine and yield.

In watermelon, Singh and Singh (1988) reported that among different characters average fruit weight and number of fruits per plant recorded the highest direct effect on yield. Indirect effect through days to first flower was negative.

Rajendran and Thamburaj (1989) found the highest direct effect on yield was by average fruit weight in watermelon. Indirect effects were positive for most of the characters, except days to first female flower, which was negative.

Pandita *et al.* (1990) found that number of fruits and fruit weight had the highest positive direct effect in round melon. Number of days for first flowering had negative direct effect on yield. Rajput *et al.* (1991) reported that in cucumber harvest period also influenced yield but its degree of association was reduced with increasing vine length.

Saika *et al.* (1995) in the path coefficient analysis in 8 genotypes of cucumber revealed that fruits per plant had maximum direct effect on yield followed by fruit weight. These traits were considered as important parameters in all selection programmes for the yield improvement in cucumber.

Paranjape and Rajput (1995) found that in bittergourd yield was mainly contributed by fruits per vine, average fruit weight, fruit size and number of flowers. The fruit weight had maximum direct bearing on yield. However, vine length, number of branches, leaf area, fruits per vine and seed content indirectly contributed towards yield.

Shibukumar (1995) reported that fruit yield was directly affected by days to first flower followed by fruits per vine, length of vine and fruit weight in watermelon. Dhaliwal *et al.* (1996) reported that in muskmelon fruit yield was directly affected by days to first flower opening followed by fruits per vine, number of flowers and fruit weight.

Gayathri (1997) reported that fruit size exerted maximum direct positive effect on yield followed by average fruit weight and fruits per plant in cucumber. In Pumpkin, Kumaran *et al,*. (1998) reported that fruits per plant exhibited the highest direct effect on yield. High indirect positive effects were exerted by fruits per plant and mean fruit weight.

Menon (1998) found that in ashgourd average fruit weight exhibited the highest positive direct effect on fruit yield followed by number of fruits, female flowers per plant, vine length, leaf area and number of seeds per fruit. Leaves per plant exhibited a negative direct effect on fruit yield.

In ridgegourd, Rao *et al.* (2000) reported that number of fruits per vine and weight of fruit had high direct effect on yield per vine while number of days for flowering had negative direct effect on yield. Sidhu and Brar (1981) made path co-efficient analysis in watermelon and found that the number of female flower and fruit weight had high positive direct effect on fruit yield. Choudhary and Mandal (1987) in path co-efficient analysis in 30 diverse genotypes of cucumber revealed fruit number, female flowers per plant, fruit length, fruit weight and fruit diameter as the important characters determining yield.

Abusaleha and Dutta (1988) also reported the highest direct effect of fruits per vine and fruit length in cucumber on yield. They also reported that direct negative effect of days to female flowering and percentage of unmarketable yield on the total fruit yield. Indirect positive and significant effect of vine length, branches per vine, fruit weight and flesh thickness on yield was also reported.

Prasad and Singh (1992) in the path analysis of yield and its components in 23 genotypes of cucumber revealed positive direct effect of vine length, days to female flower appearance, fruit weight and fruit length on yield. However, the positive direct effects of these components were partially counter balanced by their negative indirect effects.

Solanki and Shah (1992) revealed through path co-efficient analysis of 11 yield components in cucumber that vine length, number of female flowers and days to flower had positive and highly significant direct effect on fruit yield.

2.4 Genetic Divergence and Clustering of Genotypes

Nature and degree of divergence of different groups in a population is a subject of exclusive study and investigation in heterosis breeding. Genetic diversity plays an important role in plant breeding because hybrids between lines of diverse origin generally display a greater heterosis than those between closely related strains. Clustering of genotypes using Mahalanobis D^2 statistic measures the degree of diversification and determines the relative proportion of each component character to the total divergence. The genotypes grouped together in a single cluster are less divergent than the ones which are placed in different clusters.

Ramachandran *et al.* (1981) studied genetic divergence using 25 diverse genotypes of bittergourd. Observations were recorded on 8 quantitative characters. The genotypes were grouped into 10 clusters in which yield per plant, fruits per plant and fruit size contributed predominantly to the total divergence.

Kadam and Kale (1985) studied genetic divergence for 14 quantitative characters in a collection of 30 cultivars in ridgegourd. The 30 cultivars were grouped into 20 clusters and fruit number per vine and yield per vine were noticed to be important factors contributing towards divergence.

Mathew *et al.* (1986) estimated the genetic distance among 5 botanical varieties of *cucumis melo* for 4 genetic characters. Of the 4 characters studied seeds per fruit did not contribute to total divergence while fruits per plant contributed the maximum. The distance was greatest between muskmelon (*var.inodorus*) and snakemelon (*var.flexuosus*) and least between longmelon (*var.utilissimum*) and snapmelon (*var. momordica*).

Vahab (1989) found that the bittergourd genotypes differed for all the 18 characters studied. The genotypes were grouped into 5 clusters. Varghese (1991) grouped 48 genotypes of snakegourd into 10 clusters in which fruit weight, fruit number and yield per plant contributed maximum to total divergence. Maximum number of genotypes was present in the cluster I (13) followed by III and V.

Parhi *et al.* (1993) studied genetic divergence in bittergourd for 14 quantitative characters. The 13 genotypes were grouped into 6 clusters. The characters 100 seed weight, number of seeds per fruit and yield per plant made maximum contribution to divergence. Babu *et al.* (1996) classified fifty pumpkin genotypes into 5 clusters based on Mahalanobis D^2 statistics, containing 2,7,9,12 and 20 genotypes respectively.

Mathew (1999) assessed genetic diversity in a collection of 34 genotypes of snakegourd. Maximum contribution to total divergence was recorded by days to first female flower, fruit weight, crop duration and number of seeds per fruit. Rios *et al.* (1997) in a multivariate analysis of pumpkin genotypes identified 6 clusters and it was recorded that skin colour and yield contributed most to genotype clustering.

2.5 Selection Index

The economic worth of a plant depends upon several characters. While selecting a desirable plant from a segregating population, the plant breeder has to give due consideration to characters of economic importance. Selection index is one such method of selecting plants for crop improvement based on several important characters. This method was proposed by Smith (1947) using Fisher's (1936) discriminant function.

Shibukumar (1995) formulated a selection index for twenty genotypes in watermelon using the characters yield per plant, number of fruits per plant, weight of individual fruit and total soluble solids. With 20% selection, the varieties Sugar Baby, Asalin Yamato, HW1 and Fuken were identified superior and suitable for cultivation.

Gayathri (1997) prepared selection index for a collection of cucumber genotypes based on major components of yield namely, node to first female flower, days to first harvest, fruits per plant, average fruit weight, fruit length, fruit girth, fruit diameter and yield per plant. The highest index score was recorded by CS 12 followed by CS 11, CS 9 and Punerikhira.

Genotypic and phenotypic correlation of different morphological characters with yield have to be analysed. The direct and indirect relationship of the yield attributes can be studied by path coefficient analysis (Wright, 1921). The genetic divergence in the varieties can be studied by D^2 analysis (Mahalanobis, 1936). Application of selection index (Dabholkar, 1992) is a promising approach to identify superior varieties.

MATERIALS & METHODS

3. MATERIALS AND METHODS

The present programme was undertaken to study the genetic divergence of different genotypes, to study the genetic basis and variability for different characters in the available germplasm, to study the direct and indirect components of yield, to identify superior varieties through discriminant function analysis in ivygourd. The experiments were conducted in the garden land of Department of Plant Breeding and Genetics, College of Agriculture, Vellayani during the period of 1999-2001.

3.1 EXPERIMENT NO.I: GENETIC DIVERGENCE ANALYSIS.

3.1.1 Materials

The basic material for the study included fifty genotypes of ivygourd including ten male lines and forty gynoecious lines collected from different agro-climatic regions of Kerala, Tamil Nadu, Karnataka and Andhra Pradesh. The details of the accessions collected are given in the Table 3.1.

3.1.2 Methods

3.1.2.1 Design and Layout

The vine cuttings of pencil thickness from fifty genotypes were planted in randomized block design with three replications during September 1999. In each replication five plants were maintained. Plot size was 7.5 m x 4.5 m with a spacing of 1.5 m each, between rows and between plants in a row.

Table 3.1 Local cultivars used in Experiment I

Sl. No.	Treatment No.	Name of local cultivars
1	T_1	Surli local I
2	T_2	Surli local II (male line)
3	T_3	Alankar local
4	T_4	Nelkiladi local
5	T_5	Maiyalthadka local I (male line)
6	T_6	Maiyalthadka local II
7	T_7	Balthangadi local I
8	T_8	Balthangadi local II (male line)
9	T_9	Balthangadi local III
10	T_{10}	Bandargram local I
11	T_{11}	Bandargram local II
12	T_{12}	Bandargram local III (male line)
13	T_{13}	Chengalpattu local
14	T_{14}	Poyale local I
15	T_{15}	Poyale local II
16	T_{16}	Meladkai local I
17	T_{17}	Meladkai local II
18	T_{18}	Meladkai local III (male line)
19	T_{19}	Kuriyabandar local I
20	T_{20}	Kuriyabandar local II
21	T_{21}	Kuriyabandar local III
22	T_{22}	Aladke local
23	T_{23}	Puthur local I
24	T_{24}	Puthur local II
25	T_{25}	Puthur local III (male line)

Table 3.1 (Contd.....)

26	T_{26}	Nilambur local
27	T_{27}	Seethambeta local I
28	T_{28}	Seethambeta local II
29	T_{29}	Kumbadaje local I
30	T_{30}	Kumbadaje local II (male line)
31	T_{31}	Perdala local I
32	T_{32}	Perdala local II
33	T_{33}	Bela local I
34	T_{34}	Bela local II
35	T_{35}	Bela local III (male line)
36	T_{36}	Seethangoli local I
37	T_{37}	Seethangoli local II
38	T_{38}	Mannarkad local I
39	T_{39}	Mannarkad local II
40	T_{40}	Ubrangala local I
41	T_{41}	Ubrangala local II
42	T_{42}	Pilangatta local I
43	T_{43}	Pilangatta local II (male line)
44	T_{44}	Pilangatta local III
45	T_{45}	Neerchal local I
46	T_{46}	Neerchal local II
47	T_{47}	Neerchal local III
48	T_{48}	Panamaram local
49	T_{49}	Kudlu local I (male line)
50	T_{50}	Kudlu local II

* Cultivars are named after their locality of cultivation
* Different cultivars of same locality are numbered as I, II etc.
* Only male lines are mentioned in brackets, all others are female lines.

3.1.2.2 Cultural Practices

The entire land was well prepared incorporating farm yard manure @ 20 t/ha. Vine cuttings of 25-30 c.m. having 1.5 c.m. to 2 c.m. thickness were planted 2 nodes deep in the soil on separate mounts. Pandals were provided for each individual plant for trailing. Fertilizers at the rate of 28:10:10 g NPK were given per plant at the time of planting and at regular intervals of four months. Weeding and raking of the soil were done at the time of fertilizer application. Regular irrigation was given during dry periods. Need based application of insecticides was done to protect the crop from insect pests.

3.1.2.3 Biometric Observations

Five plants per genotype were selected for recording the biometric observations. The following observations were made adopting standard procedures and average values were recorded for each replication.

1. Main vine length (m)

   Length of the main vine from the base of the plant to the top of the plant was measured and recorded after harvest.

2. Number of main branches per plant

   The number of primary branches of each plant was counted and average recorded.

3. Single leaf area (cm^2)

   Leaf area of five selected leaves from each plant was measured using graphical method and the average was recorded as single leaf area.

4. Number of leaves at maximum spread

   At the time of first harvest the number of leaves from each plant in a plot was counted and the average number of leaves per plant was estimated.

5. Green weight of shoot at harvest (kg)

   Shoots of each plant was weighed after completion of harvest and the average weight was recorded.

6. Root : shoot ratio

   Root : shoot ratio was recorded as the ratio between the weight of the root to the weight of the shoot.

7. Days to first flowering

   Number of days taken from planting to opening of the first flower was recorded.

8. Number of flowers per plant

   The total number of flowers produced on each plant was counted and the average was recorded.

9. Tuber characteristics

   Observations for the presence or absence of tubers were made and if tubers present, categorised into long, medium and short.

10. Incidence of pests and diseases

    No significant incidence of pests or diseases were noticed in the crop in any of the growth stages and hence no scoring for pests and disease incidence was done.

3.1.2.4 Statistical Analysis

Mahalanobis (D^2) Analysis (1936) was applied for classificatory studies by Murthy and Arunachalam (1966) in crop plants. The same methodology was applied to cluster the fifty genotypes of ivygourd in the experiment.

For i^{th} and j^{th} genotypes, the D^2 value is computed as

$$D^2 = \sum_{l=1}^{k} (X_i l - X_j l)^2$$

where k is the number of characters.

The genotypes were grouped into several clusters based on the D^2 values by Tochers method of clustering (Rao, 1952).

3.2 EXPERIMENT NO. II

3.2.1 Materials

Forty genotypes comprising only gynoecious lines of ivygourd collected from Kerala, Tamil Nadu, Karnataka and Andhra Pradesh constituted the material for Experiment No.II. The details of the accessions collected are given in Table 3.2.

3.2.2 Methods

3.2.2.2 Design and Layout

The vine cuttings of the forty genotypes were planted in randomized block design with three replications. In each replication five plants were maintained for taking the observation. Plot size and spacing were same as that of Experiment I.

Table 3.2 Local cultivars used in Experiment II

Sl. No.	Treatment No.	Name of local cultivars
1	T_1	Guthigar local
2	T_2	Alankar local
3	T_3	Uppinangadi local
4	T_4	Bela local
5	T_5	Thakazhi local
6	T_6	Dharmasthala local I
7	T_7	Dharmasthala local II
8	T_8	Pilangatta local
9	T_9	Uduppi local I
10	T_{10}	Uduppi local II
11	T_{11}	Salem local
12	T_{12}	Coimbatore local
13	T_{13}	Nagercoil local
14	T_{14}	Madurai local
15	T_{15}	Pulpa local
16	T_{16}	Chungathara local
17	T_{17}	Ettumanoor local
18	T_{18}	Subrahmania local I
19	T_{19}	Subrahmania local II
20	T_{20}	Thavinjal forest
21	T_{21}	Nangikadapuram local
22	T_{22}	Bandargram local
23	T_{23}	Kumbala local
24	T_{24}	Mugrali local
25	T_{25}	Mangalpadi local

Table 3.2 (Contd.....)

26	T_{26}	Hosangadi local
27	T_{27}	Paivalika local
28	T_{28}	Thalapadi local
29	T_{29}	Padanakad local
30	T_{30}	Kanjangad local
31	T_{31}	Kuruthur local
32	T_{32}	Kalikadavu local
33	T_{33}	Thalapuzha local
34	T_{34}	Mancheswaram local
35	T_{35}	Mananthavady local
36	T_{36}	Alappuzha local
37	T_{37}	Thirunelli local
38	T_{38}	Nekeraje local
39	T_{39}	Konni local
40	T_{40}	Thodupuzha local

* Cultivars are named after their locality of cultivation

* Different cultivars of same locality are numbered as I, II etc.

3.2.2.2 Cultural Practices

Preparation of land, planting of vine cuttings, manuring etc. were done as for Experiment No.I.

3.2.2.3 Biometric Observations

The observations recorded were same as those in Experiment I. Additionally, the following observations were also recorded. Five plants per genotype were selected for recording the observations and average values were recorded.

1. Number of fruits per plant

   The total number of fruits produced on each plant was counted and the average was recorded.

2. Fruit yield per plant (kg)

   Fruit yield per plant was computed as the sum total of the weight of all the fruits in that plant harvested at regular intervals expressed in kilograms.

3. Mean fruit weight (g)

   The sum of the weight of five fruits selected at random from each plant was taken and their average was expressed in grams.

4. Single fruit size by volume (cc)

   Five random fruits from each plant was taken and their volume was measured by the water displacement method using a measuring cylinder.

The average was taken and expressed as volume of the fruit in cubic centimeter.

5. Shape of fruit

Shape of the fruits was observed by visual observation and were recorded as round, oblong, oval and cylindrical.

6. Number of seeds per fruit.

The seeds were taken from five fruits and the total number was counted and the mean was recorded.

7. Protein content in fruits

Protein content in fruits was analysed using micro-kjeldahl method and was recorded (Sadasivam and Manickam, 1996).

8. Vitamin A in fruits (IU/100g)

Vitamin A in fruits was estimated using colorimetric method and expressed as IU per 100 gm (Sadasivam and Manickam, 1996).

9. Vitamin C in fruits (mg/100g)

Vitamin C in fruits was estimated using volumetric method and expressed as mg. per 100 gm (Sadasivam and Manickam, 1996).

3.2.2.4 Statistical Analysis

Analysis of variance (ANOVA) and covariance (ANCOA) for randomized block design (RBD) in respect of the various characters were done.

Mean - The mean of the i^{th} character Xi (xi) was worked out.

Variance and Covariance

The variance and covariance components were calculated as per the following formulae.

For the character Xi,

· Environmental variance, σ_{ei}^2 $= MSE$

· Genotypic variance, σ_{gi}^2 $= \frac{MST - MSE}{\Upsilon}$

· Phenotypic variance, σ_{pi}^2 $= \sigma_{gi}^2 + \sigma_{ei}^2$

where MST and MSE are the mean sum of squares for treatment and error respectively and Υ, the number of replications.

· Environmental covariance, σ_{eij} $= MSPE$

· Genotypic variance, σ_{gij} $= \frac{MSPT - MSPE}{\Upsilon}$

· Phenotypic variance, σ_{pij} $= \sigma_{gij} + \sigma_{eij}$

where MSPT and MSPE are the mean sum of products between the i^{th} and j^{th} characters for genotype and environment from ANCOA respectively and Υ, the number of replications.

Genetic Parameters

Coefficient of Variation

Variability that existed in the population for various characters were apportioned using the estimates of coefficient of variation.

For the character Xi,

- Phenotypic coefficient of variation, PCV $= \frac{\sigma_{pi} \times 100}{xi}$

- Genotypic coefficient of variation, GCV $= \frac{\sigma_{gi} \times 100}{xi}$

- Environmental coefficient of variation, ECV $= \frac{\sigma_{ei} \times 100}{xi}$

where σ_{pi}, σ_{gi} and σ_{ei} are the phenotypic, genotypic and environmental standard deviations respectively.

Heritability and Genetic advance

Jain (1982) proposed the mathematical relationship of variance estimates on computation of heritability, which is usually expressed as a percentage.

Heritability (broad sense), $H^2 = \frac{\sigma_{gi}^2}{\sigma_{pi}^2} \times 100$

The heritability percentages were categorized as suggested by Robinson *et al.* (1949) namely, low (0 – 30), moderate (30 – 60) and high (above 60).

Genetic advance under selection

Genetic advance as percentage of mean was calculated as per the formula given by Lush (1949).

$$\text{Genetic advance, GA} = \frac{kH^2 \sigma_{pi}}{\overline{X}i} \times 100$$

where H^2 - heritability in broad sense

σ_{pi} - phenotypic standard deviation

K - selection differential that is 2.06 in case of 5% selection in large samples (Miller *et al.* 1958).

Genetic advance as percentage was categorized into low (<20%) and high (>20%) as suggested by Robinson *et al.* (1949).

Correlation Analysis.

The correlation coefficients (phenotypic, genotypic and environmental) between two characters denoted as i and j were worked out as

- Genotypic correlation (rgij) $= \dfrac{\sigma_{gij}}{\sigma_{gi} \times \sigma_{gi}}$
- Phenotypic correlation (rpij) $= \dfrac{\sigma_{pij}}{\sigma_{pi} \times \sigma_{pj}}$
- Environmental correlation (reij) $= \dfrac{\sigma_{eij}}{\sigma_{ei} \times \sigma_{ej}}$

where σ_{gij}, σ_{pij} and σ_{eij} are the genotypic, phenotypic and environmental covariances between the characters i and j. σ_{gi}, σ_{pi} and σ_{ei} are the genotypic, phenotypic and environmental standard deviations for the character i and σ_{gj}, σ_{pj} and σ_{ej} are the genotypic, phenotypic and environmental standard deviations for the character j.

Path coefficient analysis.

Path analysis is applied to identify relatively important component characters (which are the independent variables) of 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

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

where $\underset{\sim}{A}$ is the genotypic inter-correlation matrix with respect to independent variables, $\underline{B}$ is the column vector of path coefficients and $\underline{C}$ is the column vector of genotypic correlation coefficients between the dependent and independent variables. Vector $\underline{B}$ provides estimates of path coefficients which means the direct effect of the independent variable on the 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).

Selection index

Selection index proposed by Smith (1947) based on discriminant function of the observable characters was used to select the genotypes for crop improvement. The phenotype was expressed as

$I = b_1x_1, + b_2x_2 +$ ------------ $+ b_nx_n$ where 'n' characters were involved and the genetic worth H, of a plant is defined as $H = a_1, G_1 + a_2G_2 +$ --------- $+ a_nG_n$ where G_1, G_2 ------ G_n represent the genotypic value of the characters and a_1, a_2 ----------, a_n denote the weights to be assigned to each character. The 'b' coefficients were determined such that the correlation between H and I is maximum, so that maximum gain can be expected in the selection of the phenotype. This will lead to the solution of the system of matrix equations given by $\underset{\sim}{P}\ \underline{b} = \underset{\sim}{G}\ \underline{a}$ where $\underset{\sim}{P}$ and $\underset{\sim}{G}$ are the phenotypic and genotypic variance – covariance matrix respectively, $\underline{b}$ is the column vector of b coefficients and $\underline{a}$ the column vector of assigned weights which are taken as unity in the present case giving equal importance to each of the component characters. Selection indices were calculated to all the ecotypes and those with the highest values could be considered for further breeding programme.

RESULTS

4. RESULTS

The results of the present investigation on genetic analysis in ivygourd (*Coccinia grandis* (L.) *Voigt.*) are presented below.

4.1 Experiment No.I

Fifty genotypes of ivygourd consisting of gynoecious lines and male lines were evaluated under field conditions for studying the genetic divergence of genotypes.

4.1.1 Genetic divergence

Observations on eight characters namely, vine length, number of branches per plant, leaf area, number of leaves per plant, green weight of shoot at harvest, root : shoot ratio, number of days taken for first flowering and number of flowers per plant was subjected to Mahalanobis D^2 analysis. Tocher's method was applied to cluster the fifty genotypes based on their pair-wise D^2 values and as such, eleven clusters were found. The group constellation of these eleven clusters are presented in Table 4.1.1(a).

VARIABILITY IN LEAF CHARACTERS

PLATE 1

Table 4.1.1 (a) Group constellations in 50 genotypes of ivygourd

Sl. No.	Cluster	No. of genotypes	Genotypes
1	I	7	T_2, T_4, T_{22}, T_{24}, T_{29}, T_{36}, T_{42}
2	II	6	T_5, T_7, T_8, T_{10}, T_{25}, T_{27}
3	III	11	T_6, T_{11}, T_{12}, T_{15}, T_{20}, T_{26}, T_{30}, T_{32}, T_{33}, T_{41}, T_{45}
4	IV	10	T_1, T_3, T_{13}, T_{14}, T_{17}, T_{23}, T_{31}, T_{34}, T_{38}, T_{40}
5	V	9	T_9, T_{16}, T_{18}, T_{35}, T_{39}, T_{46}, T_{47}, T_{48}, T_{50}
6	VI	2	T_{28}, T_{37}
7	VII	1	T_{19}
8	VIII	1	T_{21}
9	IX	1	T_{43}
10	X	1	T_{44}
11	XI	1	T_{49}

The cluster III had the highest number of genotypes (11) which includes genotypes T_6, T_{11}, T_{12}, T_{15}, T_{20}, T_{26}, T_{30}, T_{32}, T_{33}, T_{41}, and T_{45} followed by cluster IV with 10 genotypes viz., T_1, T_3, T_{13}, T_{14}, T_{17}, T_{23}, T_{31}, T_{34}, T_{38} and T_{40} and cluster V with 9 genotypes (T_9, T_{16}, T_{18}, T_{35}, T_{39}, T_{46}, T_{47}, T_{48} and T_{50}). The other clusters were cluster I with 7 genotypes viz., T_2, T_4, T_{22}, T_{24}, T_{29}, T_{36} and T_{42}, Cluster II with 6 genotypes (T_5, T_7, T_8, T_{10}, T_{25} and T_{27}) and cluster VI with 2 genotypes (T_{28} and T_{37}). The genotypes T_{19}, T_{21}, T_{43}, T_{44} and T_{49} remained as divergent genotypes that could not be accommodated in any of the other clusters and each remained as a separate cluster.

Based on total D^2 values the average inter and intra-cluster distances were estimated and presented in Tables 4.1.1(b) and 4.1.1(c) and in Fig.1. The average intra-cluster distance varied from zero (Cluster VII, VIII, IX, X and XI) to 134.11 (Cluster V). The inter-cluster distance varied from 91.16 (between clusters VIII and XI) to 2156.75 (between clusters II and IX).

The maximum and minimum divergence between clusters are presented in Table 4.1.1(d) and Fig. 2. The cluster I had the greatest distance (1948.76) from cluster IX followed by X, VI, V, VII, XI, IV, VIII, III and II respectively. The cluster IX had the maximum distance (2156.75) from cluster II followed by clusters X, VI, V, VII, XI, IV, VIII, III and I respectively. The cluster IX had the greatest distance (1664.74) from cluster III followed by clusters X, VI, V, II, VII, XI, I, IV and VIII respectively. The cluster IV had maximum distance (1405.77) from cluster IX followed by clusters X, VI, II, I, V, III, VII, XI and VIII respectively. The cluster V had maximum distance (1148.32) from cluster II followed by clusters IX, I, III, X, VIII, VI, IV, XI and VII respectively. The cluster VI had maximum distance (1542.63) from cluster II followed by clusters I, III, VIII, IV, XI, VII, IX, V and X respectively. The cluster VII had maximum distance (1276.34) from cluster IX followed by clusters II, X, I, VI, III, V, VIII, XI and IV respectively. The cluster VIII had maximum distance (1453.99) from cluster IX followed by clusters X, VI, II, I, V, VII, III, IV and XI respectively. Cluster IX had maximum distance (2156.75) from the cluster II followed by the clusters I, III, VIII, IV, XI, VII, V, VI and X respectively. Cluster X had maximum distance (1731.04) from the cluster II followed by the clusters I, III, VIII, IV, XI, VII, V, IX and VI respectively. Cluster XI had maximum distance (1367.35) from the cluster IX followed by the clusters X, II, VI, I, V, III, VII, IV and VIII respectively.

Among all the clusters Cluster IX exhibited very high distance from seven of the eleven clusters formed, followed by Cluster II which showed very high distance from the other four clusters. Cluster IX include only one genotype T_{43}, which is a male line. Cluster II include T_5, T_8, T_{25} (male lines) and T_7, T_{10} and T_{27} (female lines). Maximum intercluster distance was between cluster IX and Cluster II (2156.75) followed by Cluster I and Cluster IX (1948.76).

Table 4.1.1(b) **Average intra and intercluster distance (D^2)**

Clusters	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
I	**9580.46**	52698.90	91821.36	304180.49	887098.44	1781380.93	458570.10	264637.19	3797659.57	2321048.14	361967.06
II		**10438.07**	245395.28	573368.39	1318641.33	2379717.17	783630.53	511009.40	4651564.83	2996482.33	644343.58
III			**8901.01**	76293.41	432199.36	1105300.61	162404.91	53680.66	2771354.36	1525061.82	100256.58
IV				**9177.75**	165504.14	627828.16	23871.92	15841.26	1976195.00	961506.69	17779.82
V					**17985.91**	167493.94	81742.78	206101.21	1034553.22	352410.20	139073.73
VI						**1212.68**	438498.80	709962.50	378650.40	37266.52	573876.80
VII							**0.00**	53906.98	1629043.00	727532.10	34118.77
VIII								**0.00**	2114098.00	1053745.00	8309.33
IX									**0.00**	182961.10	1869637.00
X										**0.00**	883752.70
XI											**0.00**

Diagonals – intracluster distance Off diagonals – intercluster distance

Table 4.1.1 (c) Average intra and intercluster distance (D)

Cluster	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
I	**97.88**	229.56	303.02	551.53	941.86	1334.68	677.18	514.43	1948.76	1523.49	601.64
II		**102.17**	495.37	757.21	1148.32	1542.63	885.23	714.85	2156.75	1731.04	802.71
III			**94.35**	276.21	657.42	1051.33	402.99	231.69	1664.74	1234.93	316.63
IV				**95.80**	406.82	792.36	154.51	125.86	1405.77	980.56	133.34
V					**134.11**	409.26	285.91	453.98	1017.13	593.64	372.93
VI						**34.82**	662.19	842.52	615.35	193.05	757.55
VII							**0.00**	232.18	1276.34	852.95	184.71
VIII								**0.00**	1453.99	1026.52	91.16
IX									**0.00**	427.74	1367.35
X										**0.00**	940.08
XI											**0.00**

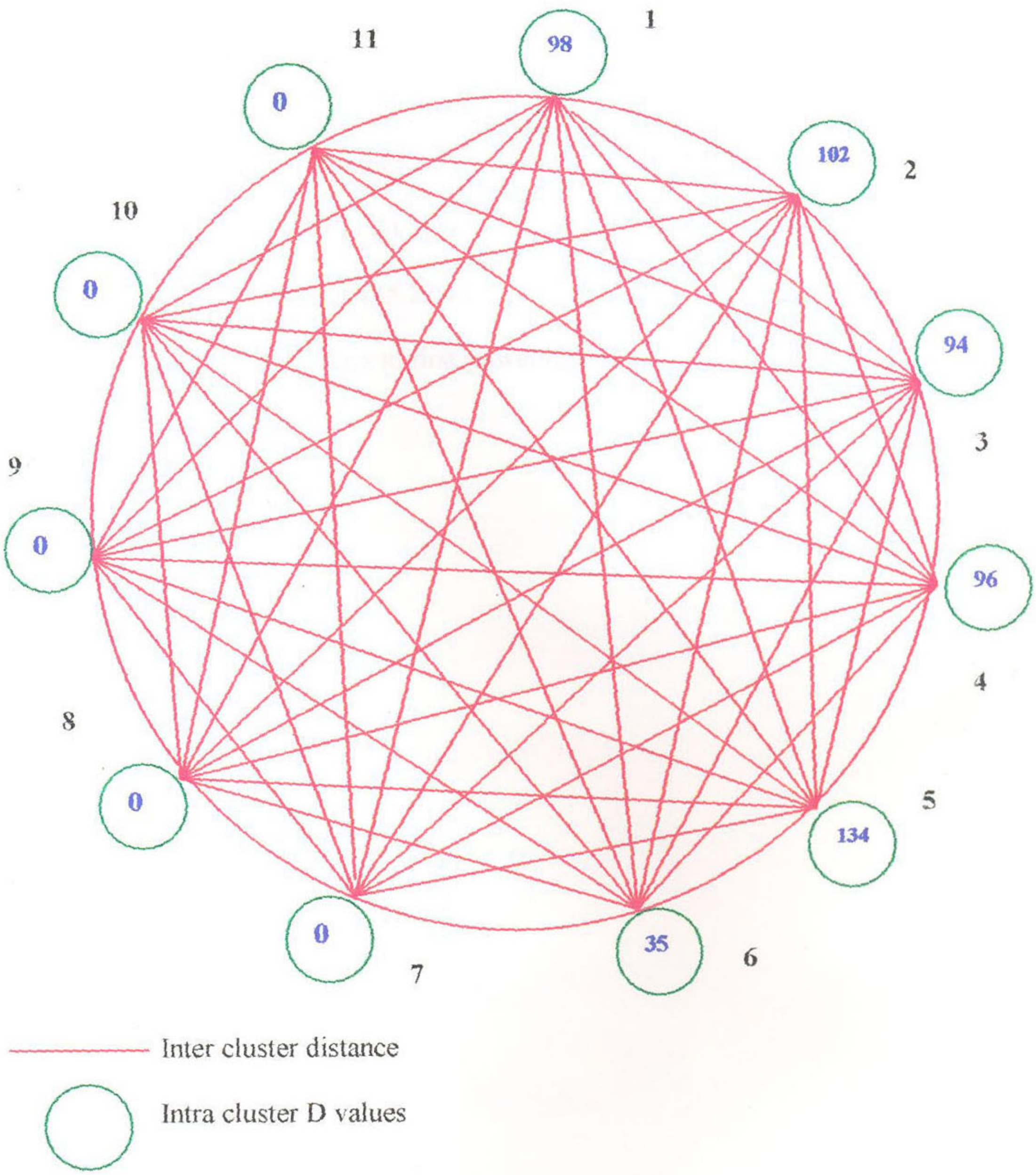
Diagonals – intracluster distance

Off diagonals – intercluster distance

Table 4.1.1(d) Maximum and minimum distance (D) between clusters

Clusters	Maximum	Minimum
Cluster I	Cluster IX (1948.76)	Cluster II (229.56)
Cluster II	Cluster IX (2156.75)	Cluster I (229.56)
Cluster III	Cluster IX (1664.74)	Cluster VIII (231.69)
Cluster IV	Cluster IX (1405.77)	Cluster VIII (125.86)
Cluster V	Cluster II (1148.32)	Cluster VII (285.91)
Cluster VI	Cluster II (1542.63)	Cluster X (193.05)
Cluster VII	Cluster IX (1276.34)	Cluster IV (154.51)
Cluster VIII	Cluster IX (1453.99)	Cluster XI (91.16)
Cluster IX	Cluster II (2156.75)	Cluster X (427.74)
Cluster X	Cluster II (1731.04)	Cluster VI (193.05)
Cluster XI	Cluster IX (1367.35)	Cluster VIII (91.16)

Fig. 1 Cluster Diagram



The cluster means of eight characters are presented in Table 4.1.1(e) and Fig. 3, 4, 5, 6, 7, 8, 9 and 10. From the table and figures, it is clear that the maximum variation was for number of flowers per plant (32.20%) followed by number of leaves per plant (19.11%), number of branches per plant (18.59%), root : shoot ratio (18.18%), leaf area (15.27%), vine length (12.69%) and green weight of shoot (9.31%). Number of days to first flowering contributed minimum (7.94%) towards the divergence.

Fig.2 Maximum & minimum divergence between clusters

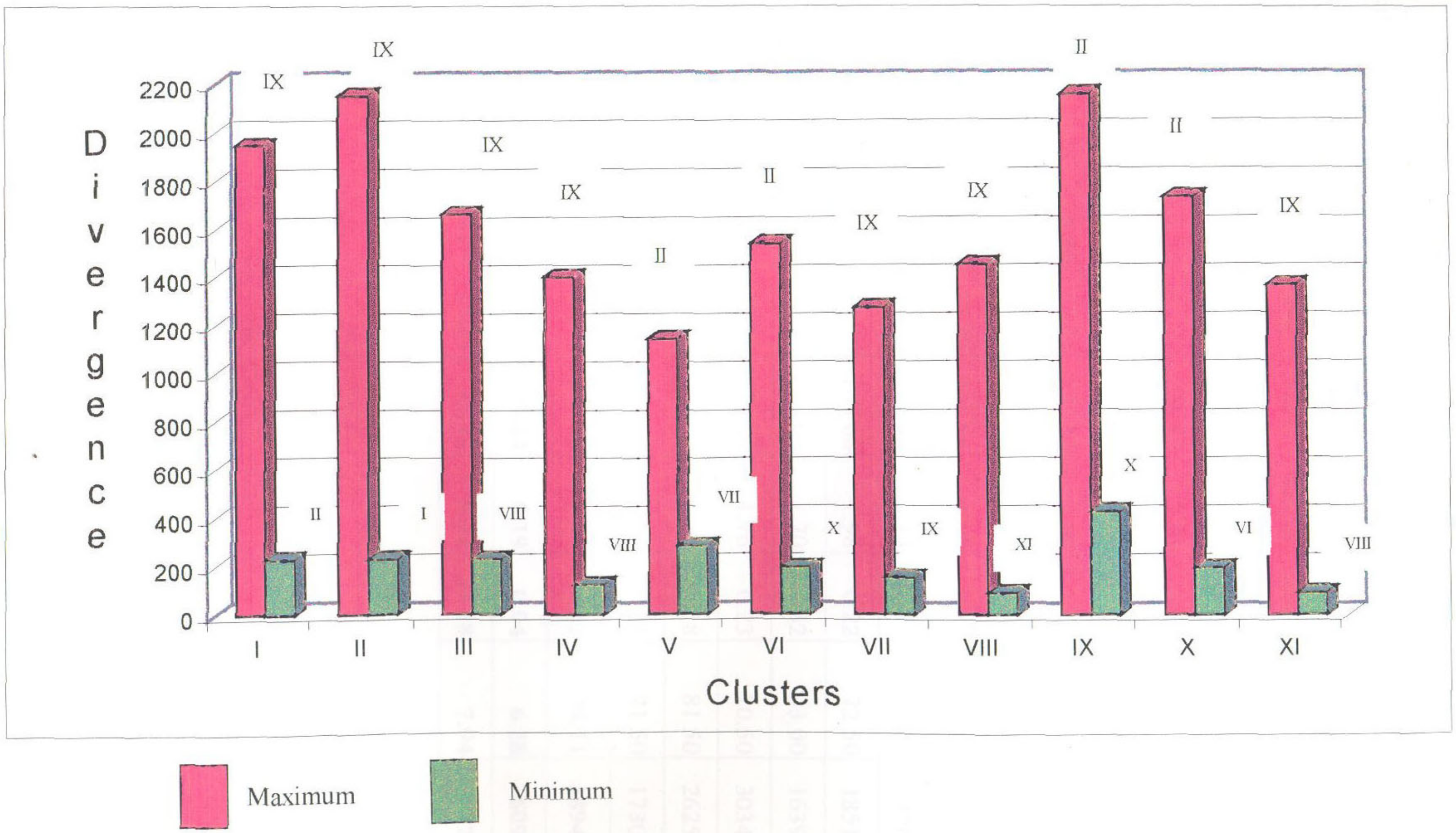


Table 4.1.1 (e) Cluster means of 8 characters in ivygourd

Clusters	Vine Length (m)	No. of bran-ches	Leaf area (c.m^2)	No. of leaves	Green weight of shoot (Kg)	Root shoot ratio	No. of days taken for first flowering	No. of flowers per plant
I	2.06	4.93	53.32	228.64	2.01	0.22	78.79	1215.21
II	2.07	4.08	55.50	249.58	2.18	0.21	78.08	1017.58
III	2.08	4.50	53.74	272.32	2.25	0.22	82.23	1469.05
IV	1.95	4.60	51.00	237.20	2.14	0.22	81.00	1717.35
V	1.85	3.94	52.22	248.56	1.97	0.19	79.61	2080.22
VI	1.55	3.75	52.00	219.00	2.13	0.17	81.50	2458.00
VII	1.84	3.00	42.40	183.00	1.98	0.22	72.50	1851.50
VIII	1.59	6.00	44.40	334.00	1.70	0.32	93.00	1639.50
IX	1.55	3.50	52.65	218.00	1.76	0.23	70.50	3034.00
X	1.91	4.00	72.35	254.00	2.01	0.18	81.50	2625.00
XI	1.55	4.50	44.75	344.50	2.36	0.21	71.50	1730.50
Mean	**1.82**	**4.25**	**52.21**	**253.53**	**2.04**	**0.22**	**79.11**	**1894.36**
S.D	**0.22**	**0.79**	**7.97**	**48.44**	**0.19**	**0.04**	**6.28**	**609.98**
C.V(%)	**12.69**	**18.59**	**15.27**	**19.11**	**9.31**	**18.18**	**7.94**	**32.20**

Character-wise performance of genotypes

Fig. 3 Vine length (m)

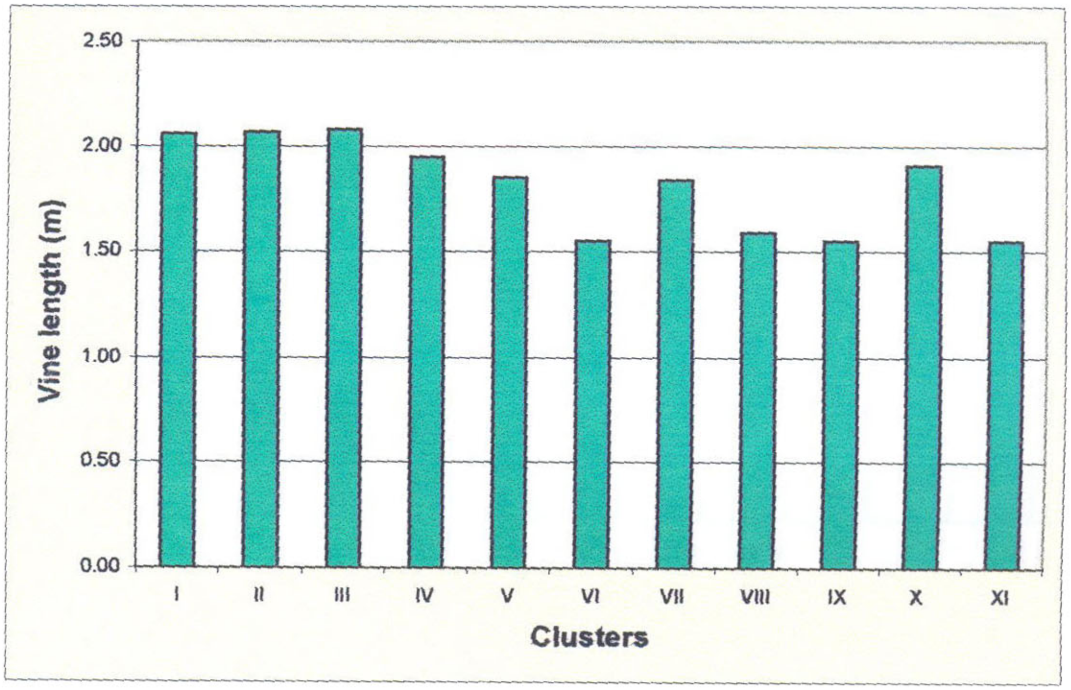
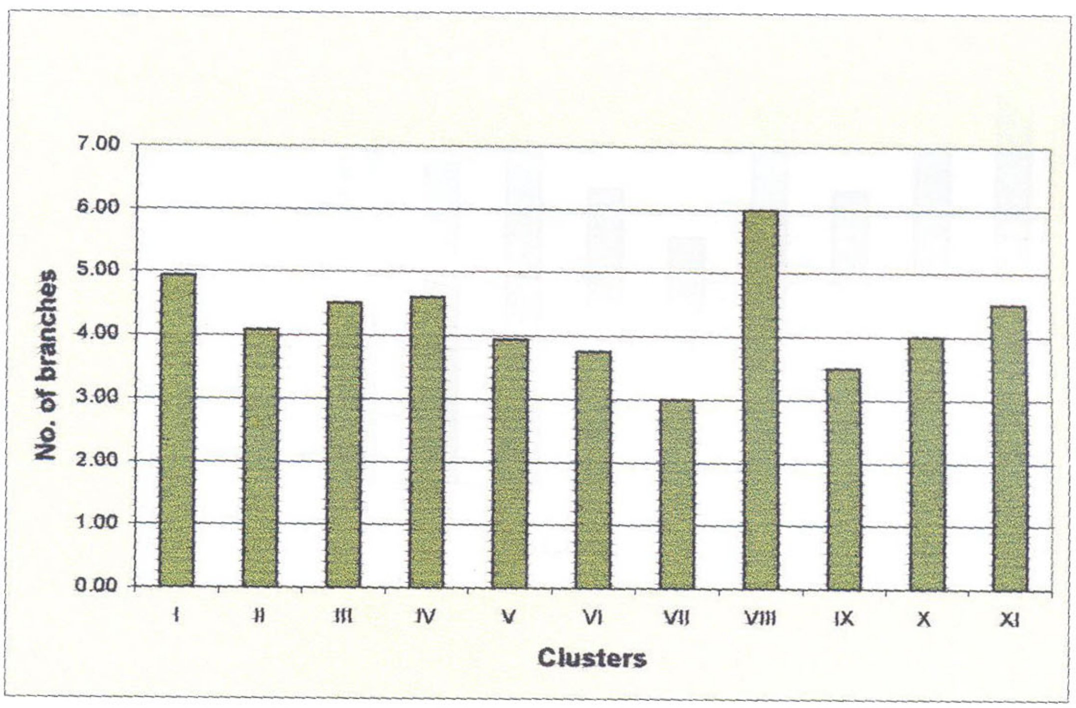


Fig. 4 No. of branches



Character-wise performance of genotypes (contd…)

Fig. 5 Leaf area (c.m.^{2})

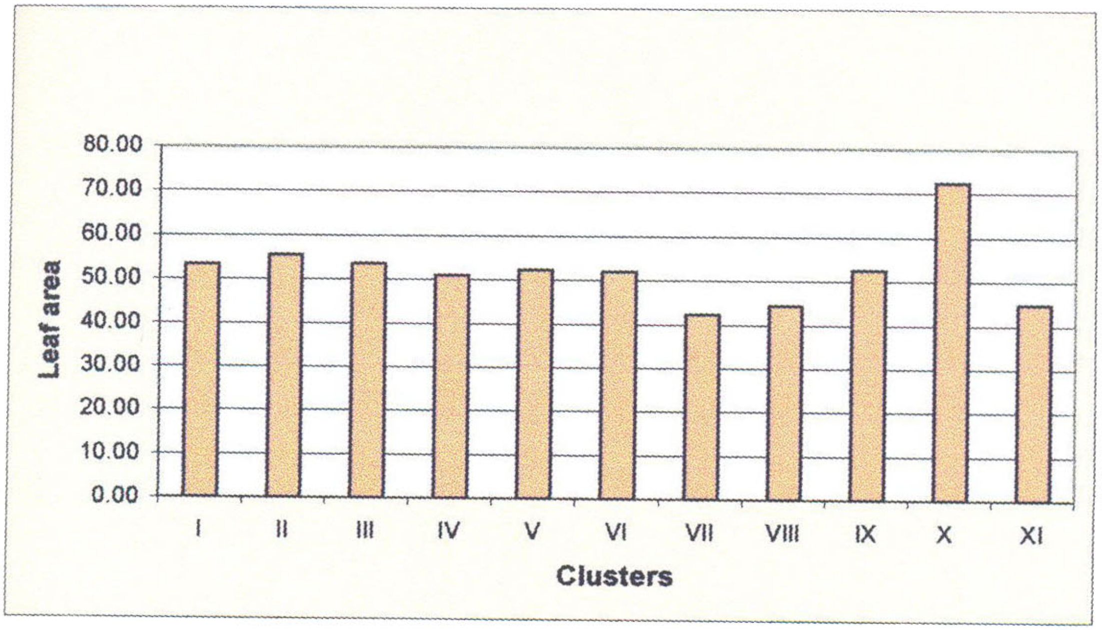
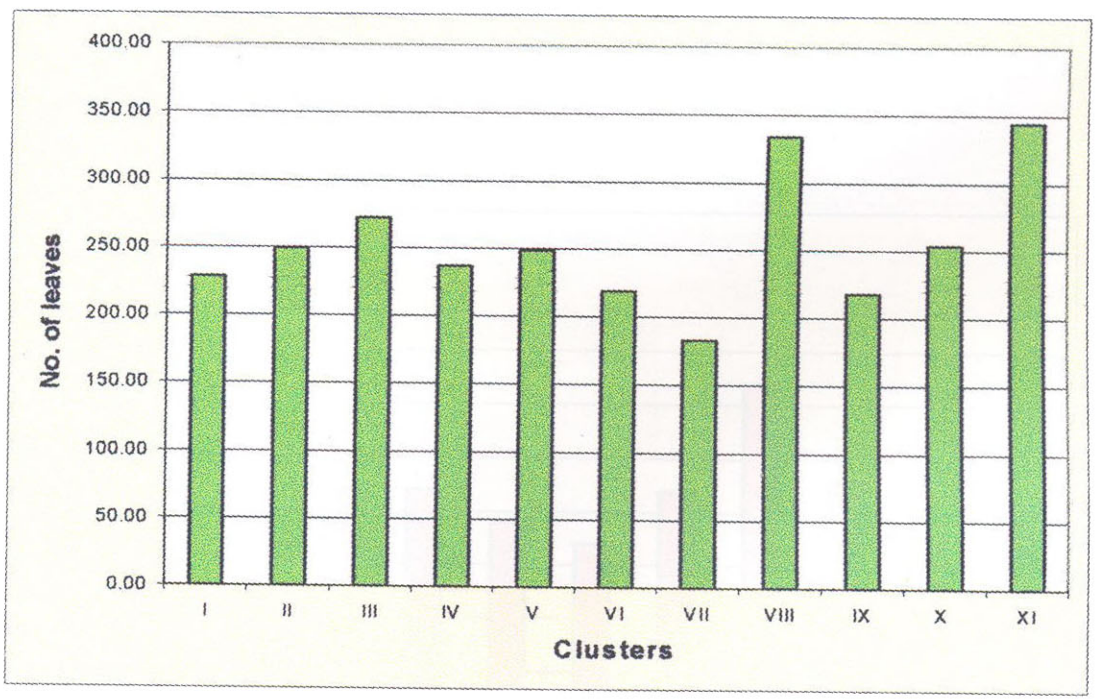


Fig. 6 No. of leaves



Character-wise performance of genotypes (Contd....)

Fig.7 Green weight of shoot (kg)

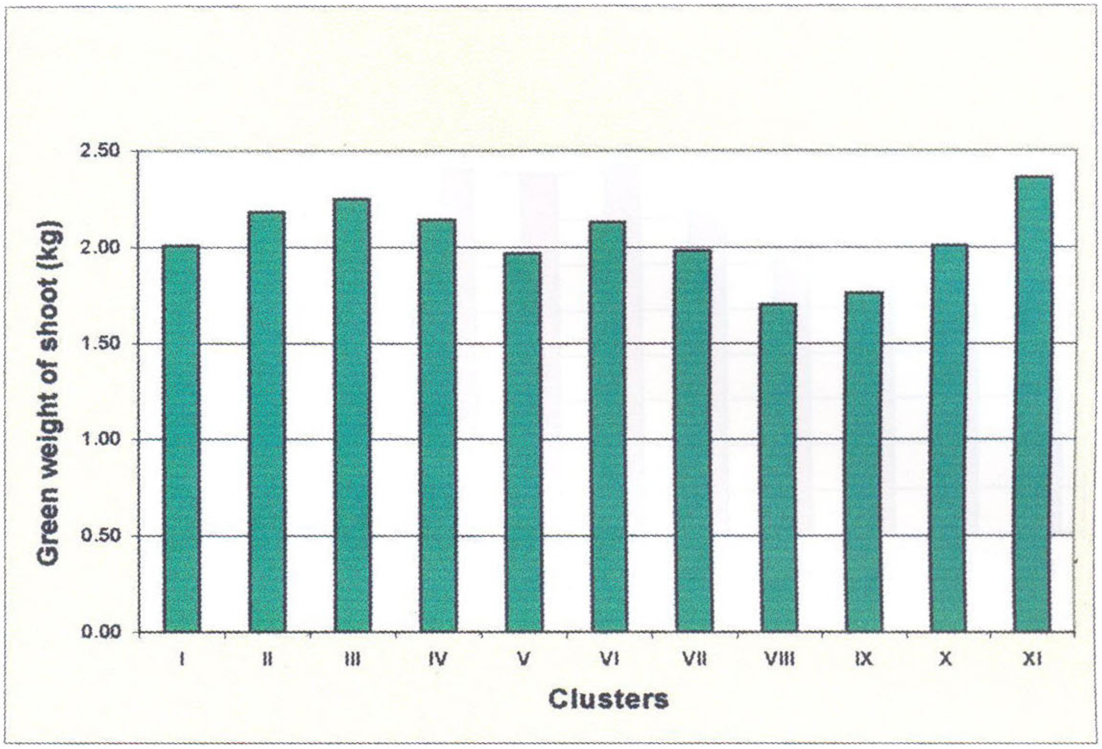
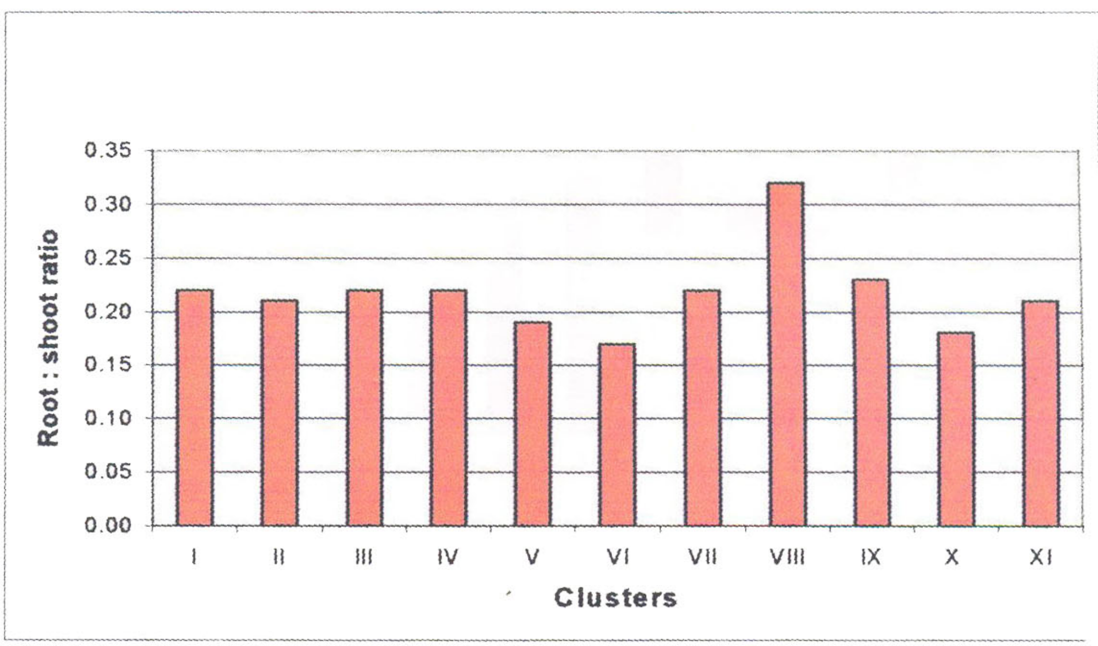


Fig.8 Root : shoot ratio



Character-wise performance of genotypes (Contd....)

Fig. 9 No. of days taken for first flowering

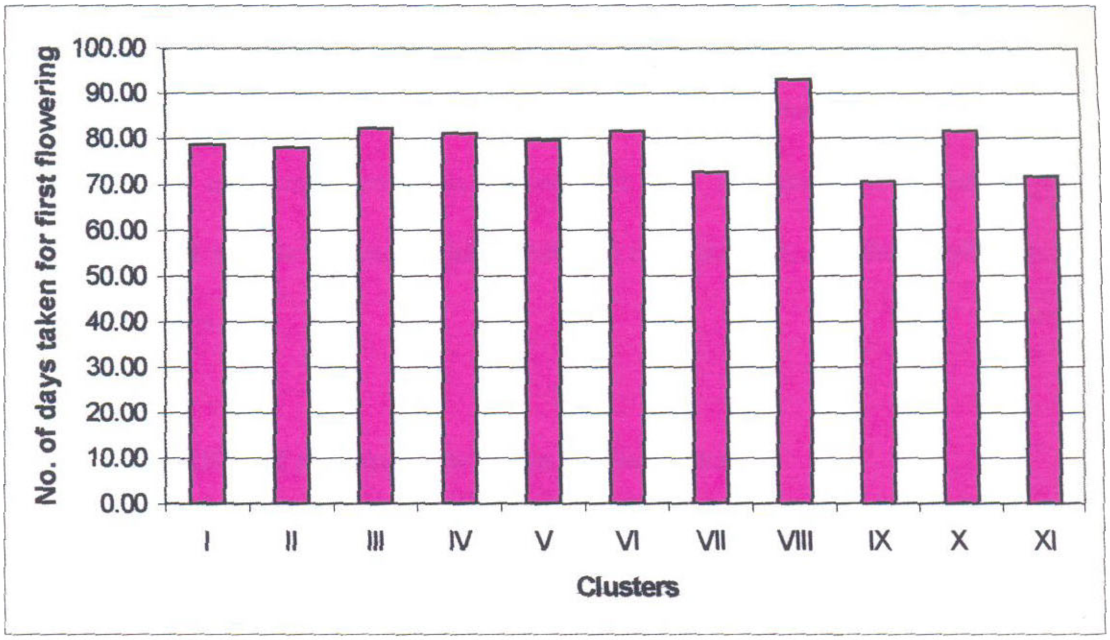
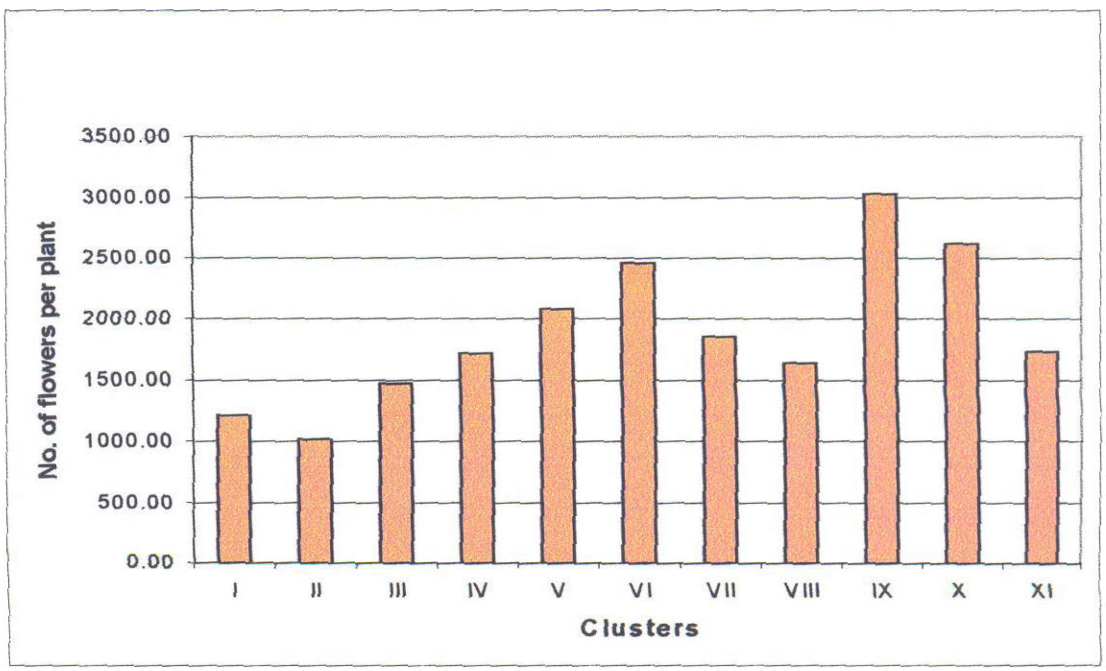


Fig.10 No. of flowers per plant



4.2 Experiment No.II

Forty genotypes of ivygourd consisting only gynoecious lines were grown in a separate plot and were evaluated. The data were subjected to statistical analysis for estimating genotypic, phenotypic and environmental variability, heritability and genetic advance and correlation of characters, and the results are presented below.

4.2.1 Evaluation of genotypes for mean performance

Analysis of variance revealed significant genotypic differences for all the characters. The mean performance among the genotypes along with the CD values are presented in Table 4.2.1(a).

Table 4.2.1(a) Varietal differentiation for 16 characters in ivygourd

Geno types	Vine length (m)	No. of branch es per plant	Single leaf area (c.m^2)	No. of leaves per plant	Green weight of shoot at harvest (kg)	Root: shoot ratio	No. of days for first flowering	No. of flowers per plant	No. of fruits per plant	Fruit yield per plant (kg)	Single fruit weight (g)	Single fruit size (cc)	No. of seeds per fruit	Protein content of fruits (%)	Vitamin A in fruits (IU/100 g)	Vitamin C in fruits (mg/100 g)
(0)	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*	*(13)*	*(14)*	*(15)*	*(16)*
1	1.80	3.50	53.75	191.00	1.65	0.28	91.50	774.80	601.20	9.69	12.66	25.50	80.50	2.20	168.68	24.88
2	2.68	6.50	42.50	322.50	2.73	0.23	72.50	1692.80	1321.20	20.15	14.11	19.00	64.50	2.55	203.77	26.52
3	1.62	3.50	32.55	279.00	1.60	0.26	86.50	917.20	699.20	9.51	12.54	24.00	59.50	1.90	170.09	22.10
4	1.45	4.00	74.05	197.00	2.10	0.26	97.50	1173.20	872.40	10.73	12.59	21.50	81.00	2.10	224.77	17.09
5	1.61	4.50	69.80	235.50	1.70	0.28	88.50	1177.20	926.40	9.95	10.73	12.50	65.00	2.80	201.69	16.89
6	1.81	4.50	51.15	249.00	2.15	0.26	84.50	1368.80	1036.00	11.02	10.35	22.00	84.00	2.90	173.77	21.59
7	1.70	3.50	37.70	337.50	1.77	0.18	82.50	1386.80	984.80	11.70	11.61	20.50	82.00	1.90	187.96	23.81
8	1.50	3.00	39.00	328.50	1.38	0.17	93.50	1139.60	810.40	10.87	12.55	18.00	60.00	2.20	195.76	26.64
9	1.40	3.50	36.75	264.00	2.25	0.23	79.00	1574.00	1150.40	12.42	10.64	23.50	116.50	2.55	221.39	28.26
10	1.73	3.50	47.50	247.00	1.93	0.18	79.00	1400.40	978.00	10.50	10.53	15.50	67.50	2.10	251.42	25.46
11	2.20	4.50	50.55	311.00	1.80	0.32	74.00	1736.40	1216.00	12.21	9.61	21.00	79.50	2.90	234.66	21.75
12	1.85	5.00	71.35	270.00	1.90	0.26	75.00	1483.60	1036.80	16.88	15.58	26.00	112.50	2.20	222.39	26.58
13	1.47	3.50	65.50	218.00	1.50	0.19	89.00	1160.40	811.60	12.17	14.46	25.50	80.50	2.55	166.92	22.78
14	1.63	3.00	51.95	241.00	1.78	0.22	86.50	1321.20	924.40	10.98	11.26	19.50	75.50	1.90	202.12	23.40
15	1.28	3.50	34.70	224.50	1.35	0.16	95.00	943.60	688.40	11.10	15.51	20.00	66.50	2.80	183.26	21.19
16	1.65	4.00	44.70	254.00	1.43	0.19	85.00	1382.80	978.80	10.89	10.65	24.50	89.00	2.20	210.27	24.40
17	1.30	4.00	34.55	222.00	1.55	0.14	89.00	1042.00	747.60	9.83	12.71	20.00	84.00	2.10	176.45	19.59
18	1.28	2.50	38.05	210.00	1.40	0.15	101.00	795.20	588.80	9.82	13.79	12.50	61.00	1.90	183.64	21.48
19	1.50	3.50	43.20	240.50	1.65	0.19	89.50	1152.00	818.00	10.01	12.31	14.00	84.00	2.15	213.71	16.58
20	1.23	3.00	46.05	291.00	1.35	0.14	101.50	796.80	573.20	8.98	14.30	23.00	90.00	2.90	157.22	18.82

Table 4.2.1(a) (Contd....)

(0)	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*	*(13)*	*(14)*	*(15)*	*(16)*
21	2.60	5.00	85.50	334.00	2.55	0.30	71.50	1961.20	1428.80	24.05	16.57	28.50	83.50	2.70	265.66	30.57
22	1.30	3.50	36.95	217.50	1.75	0.13	88.50	958.40	693.60	8.58	11.42	25.00	88.50	2.80	221.26	23.48
23	1.63	4.50	56.40	188.50	1.75	0.15	81.00	1191.60	942.00	9.36	9.41	21.50	105.00	2.20	231.85	19.44
24	1.40	4.50	42.70	234.50	1.53	0.19	75.50	1405.60	1044.40	12.73	11.50	20.00	63.00	1.90	205.63	21.59
25	1.68	4.00	37.40	207.00	1.68	0.18	92.00	1206.00	914.40	12.20	12.56	13.00	60.00	2.10	212.81	22.69
26	1.45	3.50	61.00	235.50	1.38	0.16	84.00	1146.00	835.20	11.62	13.63	23.50	88.50	1.90	188.55	23.79
27	1.15	3.00	72.45	170.50	1.25	0.14	108.50	1293.20	1010.00	12.34	10.69	11.00	57.50	2.70	196.25	27.25
28	2.50	4.50	52.50	262.50	1.98	0.23	77.50	1578.40	1151.60	10.87	8.95	22.00	93.00	1.70	256.44	19.45
29	1.50	3.50	36.90	220.50	1.20	0.16	89.50	931.60	745.20	11.43	13.77	20.50	56.00	2.20	212.62	24.40
30	2.88	6.00	70.45	342.00	2.75	0.23	58.00	2304.80	1680.80	22.75	13.86	22.50	84.50	2.90	168.06	29.41
31	1.53	2.50	51.55	252.50	1.43	0.14	81.00	1187.60	864.80	11.02	11.45	20.00	51.50	2.50	186.64	21.74
32	1.08	2.50	36.15	181.00	1.23	0.16	99.00	565.20	418.00	7.16	13.43	19.00	59.00	2.00	242.35	24.50
33	1.45	3.50	47.15	240.50	1.83	0.21	80.00	1160.40	809.20	9.19	10.50	20.50	70.00	2.20	202.76	21.46
34	2.70	4.00	64.20	291.00	2.20	0.27	77.50	2097.60	1511.20	18.43	12.23	21.00	86.00	2.10	235.77	26.64
35	1.80	3.50	47.55	242.50	2.13	0.18	82.00	1398.00	968.40	11.77	11.54	24.00	91.00	2.55	225.49	22.25
36	2.91	4.50	72.55	312.00	2.28	0.29	67.50	2429.20	1734.00	22.12	12.79	21.50	71.00	2.20	230.39	25.63
37	2.75	4.50	56.55	286.50	1.93	0.37	69.50	2148.00	1550.00	19.35	12.57	20.00	97.50	2.90	226.11	26.19
38	2.59	4.00	53.05	282.00	2.55	0.26	72.50	1976.80	1446.80	17.80	12.15	22.50	65.50	1.90	235.31	31.52
39	1.91	3.50	45.70	261.00	1.98	0.20	86.00	1430.00	1035.60	14.87	13.62	22.00	91.50	2.80	221.59	28.26
40	2.31	4.00	54.65	258.00	1.90	0.22	72.00	1724.80	1210.00	16.02	12.46	21.50	69.50	2.50	225.66	30.90
Mean	1.79	3.88	51.17	253.81	1.81	0.21	83.84	1362.83	993.94	12.82	12.34	20.68	77.87	2.34	208.53	23.79
S.E	0.006	0.493	1.572	6.866	0.104	0.015	2.269	22.53	23.31	0.33	0.188	0.408	4.008	0.043	0.959	0.403
CD	0.192	1.410	4.497	19.643	0.297	0.042	6.490	64.45	66.70	0.96	0.539	1.167	11.466	0.122	2.744	1.153

VARIABILITY IN FRUIT CHARACTERS

FRUIT CHARACTERS OF 10 SELECTED CULTIVARS

1. T_{34}
2. T_{11}
3. T_{38}
4. T_{37}
5. T_{21}
6. T_9
7. T_{40}
8. T_{12}
9. T_2
10. T_{30}

PLATE 2A

PLATE 2B

1. Main vine length (m)

The average vine length was observed as 1.79 m with a range of 1.08m (T_{32}) to 2.75m (T_{37}) and a coefficient of variation of 2.11 per cent.

2. Number of branches per plant

The average number of branches per plant was observed to be 3.88 with a range of 2.50 (T_{18}, T_{31} and T_{32}) to 6.50 (T_2). This character exhibited maximum coefficient of variation of 79.87 per cent.

3. Single leaf area (cm^2)

The single leaf area had an average of 51.17cm^2. The single leaf area ranged from 32.55 cm^2 (T_3) to 85.50 cm^2 (T_{21}) with a coefficient of variation of 19.41 per cent.

4. Number of leaves per plant

The average number of leaves per plant was 253.81. The number of leaves per plant ranged from 170.50 (T_{27}) to 342.00 (T_{30}) with a coefficient of variation of 17.12 per cent.

5. Green weight of shoot at harvest (kg)

The green weight of shoot at harvest was 1.81 kg on an average with a coefficient of variation of 34.94 per cent. The green weight of shoot at harvest ranged from 1.20 kg(T_{29}) to 2.75 kg (T_{30}).

6. Root : shoot ratio

The average root : shoot ratio was 0.21 with a range of 0.13 (T_{22}) to 0.37 (T_{37}). The coefficient of variation was 30.11 per cent.

7. Number of days for first flowering

The average number of days for flowering was 83.54 days with a minimum of 58.00 days (T_{30}) and a maximum of 108.50 days (T_{27}). The coefficient of variation was 17.12 per cent.

8. Number of flowers per plant

The average number of flowers per plant was 1362.83. The number of flowers per plant ranged from 562.20 (T_{32}) to 2429.20 (T_{36}) with a coefficient of variation of 10.45 per cent.

9. Number of fruits per plant

The number of fruits per plant ranged between 418.00 (T_{32}) and 1734.00 (T_{36}) with an average of 993.94. The coefficient of variation was 14.83 per cent.

10 Fruit yield per plant

The average fruit yield was 12.82 kg with a range of 7.16 kg (T_{32}) to 24.05 kg (T_{21}) having a coefficient of variation of 16.57 per cent.

T_{21} - BEST CULTIVAR IDENTIFIED IN TERMS OF YIELD

T_{37} - BEST CULTIVAR IDENTIFIED IN TERMS OF PROTEIN, VITAMIN A & VITAMIN C

PLATE 3A

11. Single fruit weight

The single fruit weight ranged between 8.95 gm (T_{28}) and 16.57 gm (T_{21}) with an average of 12.34 gm. The coefficient of variation was 9.74 per cent.

12. Single fruit size

The average single fruit size was 20.68 c.c with a coefficient of variation of 12.53 per cent. The genotypes differed in their fruit size by 11.00 cc. (T_{27}) to 28.50 cc (T_{21}).

13. Number of seeds per fruit

The average number of seeds per fruit was 77.87. The number of seeds per fruit ranged from 51.50 (T_{31}) to 116.50 (T_9) with a coefficient of variation of 32.57 per cent.

14. Protein content of fruits (IU/100g)

Protein content of fruits ranged between 1.70 per cent (T_{28}) and 2.90 per cent (T_6, T_{11}, T_{20}, T_{30} & T_{37}) with an average of 2.34 per cent. The coefficient of variation for this character was 10.81 per cent.

15. Vitamin A in fruits (mg/100g)

The average Vitamin A content in fruits was 208.53 IU per 100 g, which ranged between 157.22 IU per g (T_{20}) and 265.66 IU per 100 g (T_{21}). The coefficient of variation for this particular trait was 2.91 per cent.

LITTLE LEAF SYMPTOMS

MEALYBUG INFESTATION

PLATE 6A

PLATE 6B

16. Vitamin C in fruits

The average Vitamin C content in fruits was 23.79 mg per 100 g, which ranged between 16.58 mg per 100 g (T_{19}) and 31.52 mg per 100 g (T_{38}). The coefficient of variation was 10.63 per cent.

17. Incidence of pests and diseases

There was no severe incidence of pests and diseases. However, a minor attack of mealy bug and fruit borer, and a mild incidence of powdery mildew, mosaic and little leaf were observed. The incidence of pests and diseases were not serious and hence no scoring was done.

4.2.2 Estimation of variability components

The phenotypic, genotypic and environmental variances for the 16 characters were estimated and presented in Table 4.2.2 and Fig.11.

The phenotypic variance was very low and minimum for root : shoot ratio (0.002) and was maximum (186333.33) for number of flowers per plant. The phenotypic variability exhibited by other characters were as follows: number of fruits per plant (94886.81), number of leaves per plant (1327.78), Vitamin A in fruits (459.18), number of seeds per fruit (166.84), single leaf area (117.56), number of days for first flowering (73.09), fruit yield per plant (17.57), single fruit size (9.98), Vitamin C in fruits (9.18), single fruit weight (4.17), protein content in fruits (1.25), number of branches per plant (0.63), vine length (0.18) and green weight of shoot at harvest (0.12).

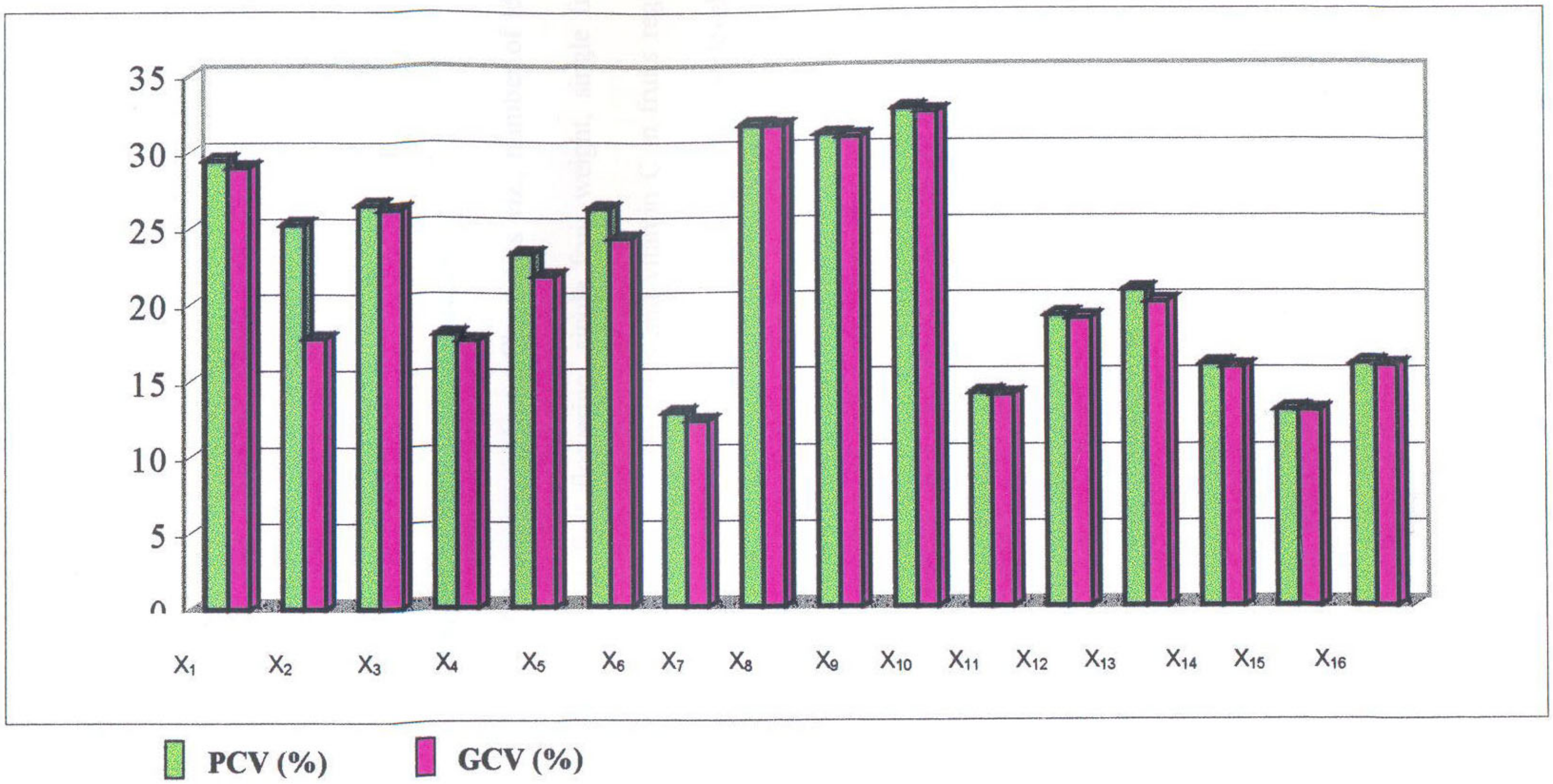
Table 4.2.2 Components of variance for 16 characters in ivygourd

Sl. No.	Characters	Variance σ_p^2	σ_g^2	σ_e^2	Coefficient of variation (%) PCV (%)	GCV (%)
1.	Vine length (m)	0.18	0.17	0.01	29.46	28.98
2.	Number of branches per plant	0.61	0.30	0.31	25.25	17.73
3.	Single leaf area (cm^2)	117.56	114.39	3.16	26.49	26.13
4.	Number of leaves per plant	1327.78	1267.44	60.34	17.95	17.53
5.	Green weight of shoot at harvest (kg)	0.12	0.10	0.01	23.26	21.79
6.	Root shoot ratio	0.002	0.0013	0.0003	26.22	24.27
7.	Number of days for first flowering	73.09	66.50	6.59	12.75	12.16
8.	Number of flowers per plant	186333.33	185318.26	1015.07	31.67	31.59
9.	Number of fruits per plant	94886.81	93799.79	1087.15	30.99	30.81
10.	Fruit yield per plant (kg)	17.57	17.34	0.22	32.68	32.47
11.	Single fruit weight (g)	4.17	-0.38	4.54	14.03	13.86
12.	Single fruit size (cc)	9.98	9.77	0.21	19.09	18.88
13.	Number of seeds per fruit	166.84	146.28	20.56	20.73	19.95
14.	Protein content in fruits (%)	1.25	-1.08	2.33	15.81	15.60
15.	Vitamin A in fruits (IU per 100 g)	459.18	458.00	1.18	12.85	12.83
16.	Vitamin C in fruits (mg per 100 g)	9.18	8.98	0.20	15.93	15.75

σ_p^2 - Phenotypic variance
σ_g^2 - Genotypic variance
σ_e^2 - Environmental variance

PCV - Phenotypic coefficient of variation
GCV - Genotypic coefficient of variation

Fig. 11 GCV and PCV for the 16 traits of ivygourd



X_1 - Vine length (m)
X_2 - Number of branches per plant
X_3 - Single leaf area (cm^2)
X_4 - Number of leaves per plant
X_5 - Green Weight of shoot at harvest (kg)
X_6 - Root shoot ratio
X_7 - Number of days for first flowering
X_8 - Number of flowers per plant
X_9 - Number of fruits per plant
X_{10} - Fruit yield per plant (kg)
X_{11} - Single fruit weight (g)
X_{12} - Single fruit size (cc)
X_{13} - Number of seeds per fruit
X_{14} - Protein content in fruits (%)
X_{15} - Vitamin A in fruits (IU per 100 g)
X_{16} - Vitamin C in fruits (mg per 100 g)

Coefficient of variation

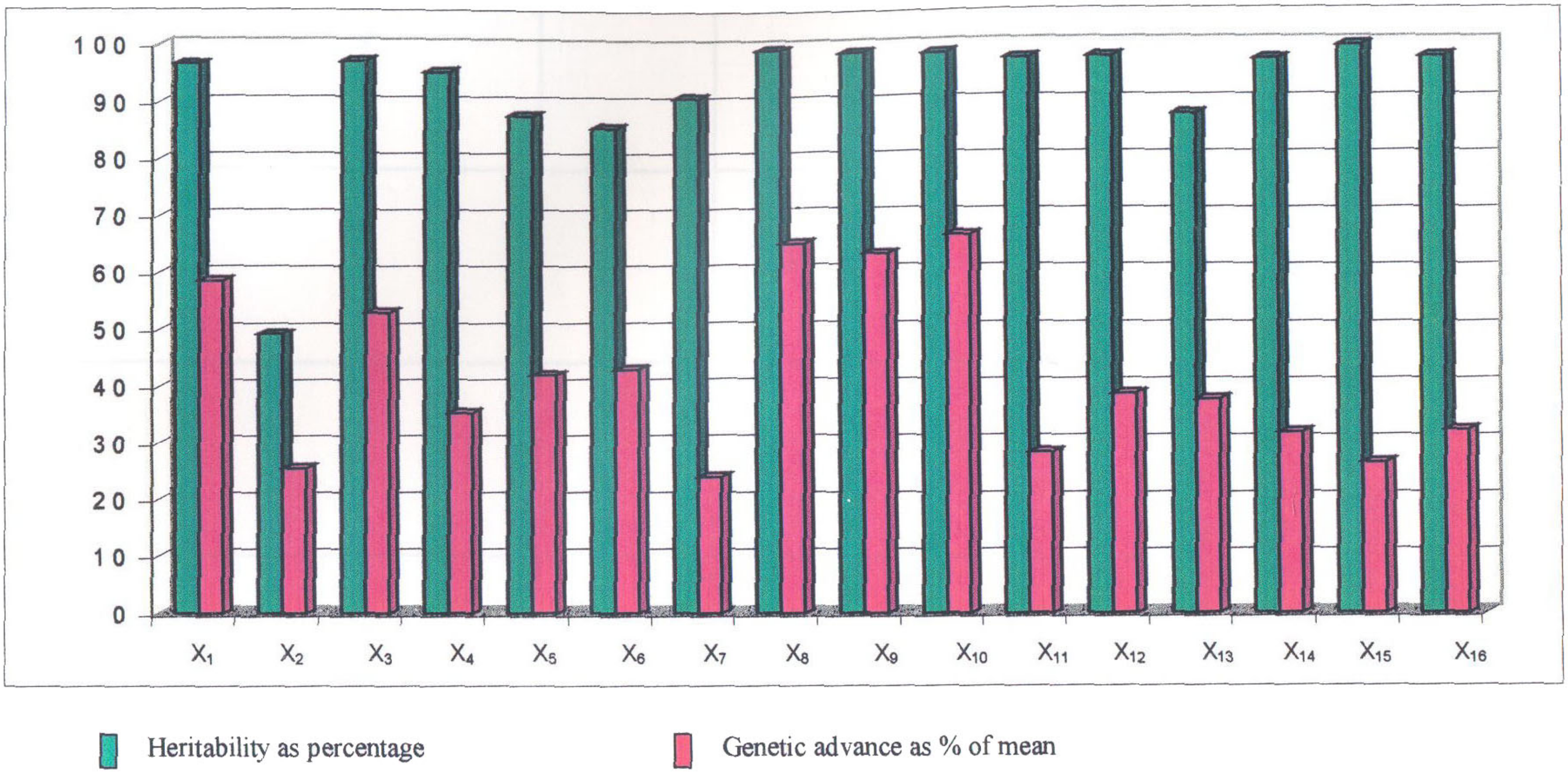
The phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were worked out and presented in the Table 4.2.2 and Fig.11.

Most of the characters maintained the same trend in the magnitude of variability at phenotypic and genotypic levels with respect to the characters studied. Least variability was recorded for the character number of days taken for first flowering followed by vitamin A in fruits both at the genotypic and phenotypic level. Maximum variability was recorded by fruit yield per plant followed by number of flowers per plant. Characters viz., number of leaves per plant, number of days for first flowering, single fruit weight, single fruit size, protein content in fruits, vitamin A in fruits and vitamin C in fruits registered a variability of less than 20 per cent both at genotypic and phenotypic levels. GCV was less than 20 per cent for number of branches per plant. 20 – 30 per cent coefficient of variation was observed in the characters vine length, single leaf area, green weight of shoot at harvest, root : shoot ratio and number of seeds per fruit at genotypic and phenotypic levels. The characters viz., number of flowers per plant, number of fruits per plant and fruit yield per plant registered a variability greater than 30 per cent at phenotypic and genotypic levels.

4.2.3 Estimation of Heritability (broad sense) and Genetic advance (as percentage of mean)

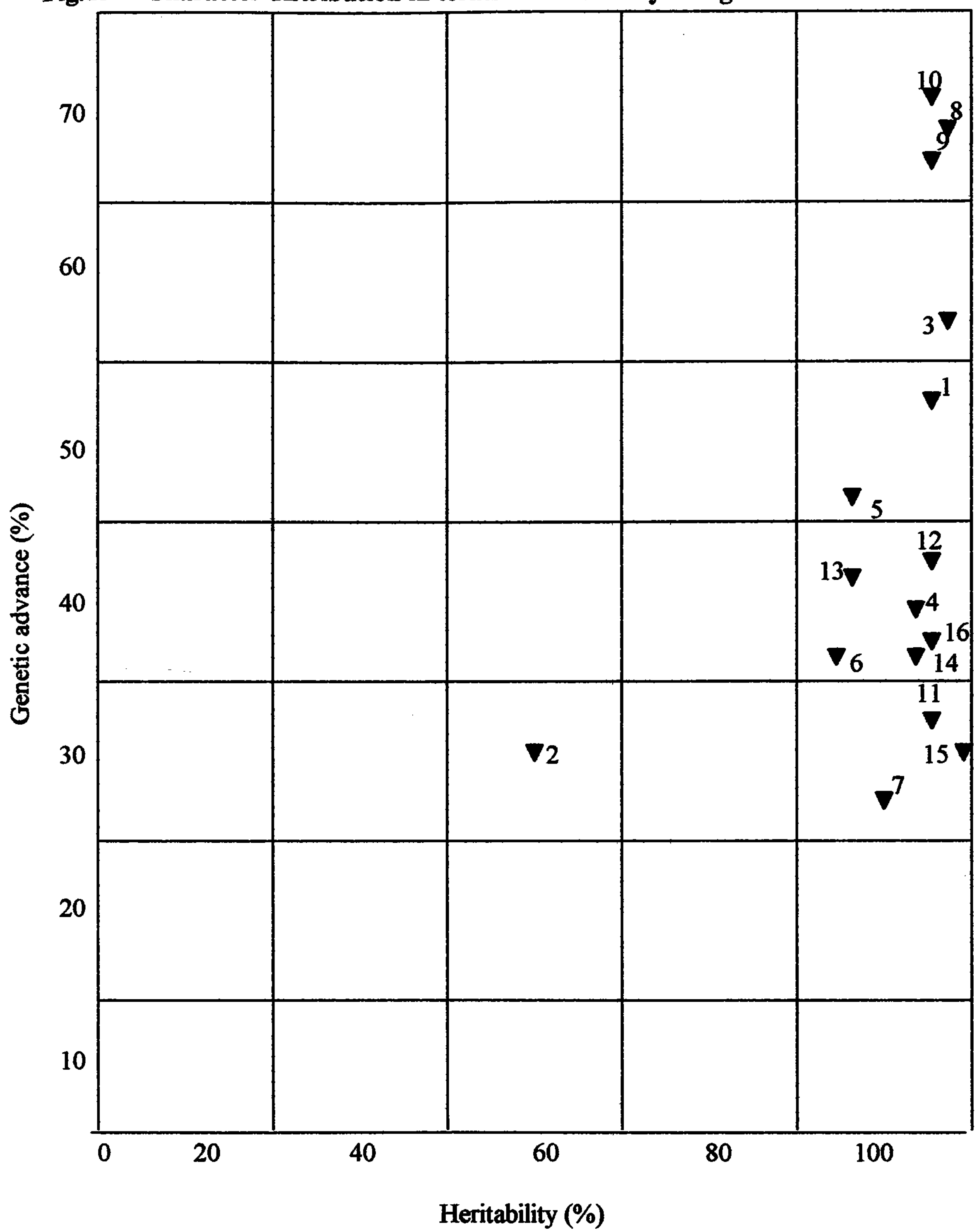
The heritability (broad sense) and genetic advance (as percentage of mean) estimates are presented in Table 4.2.3 and Fig. 12.

Fig.12 Heritability and genetic advance for 16 characteristics of ivygourd



X_1 - Vine length (m)
X_2 - Number of branches per plant
X_3 - *Single leaf area* (cm^2)
X_4 - Number of leaves per plant
X_5 - Green weight of shoot at harvest (kg)
X_6 - Root : shoot ratio
X_7 - Number of days for first flowering
X_8 - Number of flowers per plant
X_9 - Number of fruits per plant
X_{10} - Fruit yield per plant (kg)
X_{11} - Single fruit weight (g)
X_{12} - Single fruit size (cc)
X_{13} - Number of seeds per fruit
X_{14} - Protein content in fruits (%)
X_{15} - Vitamin A in fruits (IU per 100 g)
X_{16} - Vitamin C in fruits (mg per 100 g)

Fig.13 Character distribution in terms of heritability and genetic advance



1) Vine length (m) (2) Number of branches per plant (3) Single leaf area (cm^2) (4) Number of leaves per plant (5) Green weight of shoot at harvest (kg) (6) Root shoot ratio (7) Number of days for first flowering (8) Number of flowers per plant (9) Number of fruits per plant (10) Fruit yield per plant (kg) (11) Single fruit weight (g) (13) Number of seeds per fruit (14) Protein content in fruits (5) (15) Vitamin A in fruits (i.u per 100 g) (16) Vitamin C in fruits (mg per 100 g)

Table 4.2.3 Heritability and genetic advance for 16 characters in ivygourd

Sl. No.	Characters	Heritability (%)	Genetic advance (at 5%)	Genetic advance (as % of mean)
1.	Vine length (m)	96.78	1.05	58.66
2.	Number of branches per plant	49.26	0.99	25.52
3.	Single leaf area (cm^2)	97.31	27.17	53.10
4.	Number of leaves per plant	95.46	89.57	35.29
5.	Green weight of shoot at harvest (kg)	87.79	0.76	41.99
6.	Root : shoot ratio	85.71	0.09	42.86
7.	Number of days for first flowering	90.99	20.03	23.89
8.	Number of flowers per plant	99.46	1105.48	64.89
9.	Number of fruits per plant	98.85	784.11	63.11
10.	Fruit yield per plant (kg)	98.72	10.66	66.50
11.	Single fruit weight (g)	97.63	3.48	28.20
12.	Single fruit size (cc)	97.86	7.96	38.49
13.	Number of seeds per fruit	87.68	29.16	37.45
14.	Protein content in fruits (%)	97.34	0.74	31.62
15.	Vitamin A in fruits (IU per 100 g)	99.74	55.04	26.39
16.	Vitamin C in fruits (mg per 100 g)	97.74	7.63	32.07

High heritability estimates, above 60 per cent, were recorded for all the characters under study except number of branches per plant (49.26%) which comes under the medium heritability category. Maximum heritability estimate was recorded for vitamin A in fruits (99.74) followed by number of flowers per plant (99.46), number of fruits per plant (98.85), fruit yield per plant (98.72), single fruit size (97.86), vitamin C in fruits (97.74), single fruit weight (97.63), protein content in fruits (97.34), single leaf area (97.31), vine length (96.78), number of leaves per plant (95.46), number of days for first flowering (90.99), green weight of shoot at harvest (87.79), number of seeds per fruit (87.68) and root : shoot ratio (85.71).

Genetic advance as percentage of mean was maximum for fruit yield per plant (66.50) and minimum for number of days for first flowering (23.89). Estimates for other characters are as follows. Number of flowers per plant (64.89), number of fruits per plant (63.11), vine length (58.66), single leaf area (53.10), root : shoot ratio (42.86), green weight of shoot at harvest (41.99), single fruit size (38.49), number of seeds per fruit (37.45), number of leaves per plant (35.29), vitamin C in fruits (32.07), protein content in fruits (31.62), single fruit weight (28.20), vitamin A in fruits (26.39) and number of branches per plant (25.52). Thus all of the characters came under high category (>20%) as far as genetic advance is concerned.

4.2.4 Correlation among different characters

The phenotypic, genotypic and environmental correlations were estimated and presented in Tables 4.2.4(a, b & c) and Fig. 14, 15 and 16.

Phenotypic correlation

Phenotypic correlation coefficients are presented in Table 4.2.4(a) and Fig 14.

Vine length had significant positive correlation with number of branches per plant, single leaf area, number of leaves per plant, green weight of shoot at harvest, root : shoot ratio, number of flowers per plant, number of fruits per plant, fruit yield per plant, vitamin A in fruits and vitamin C in fruits. But it recorded negative and significant correlation with number of days for flowering.

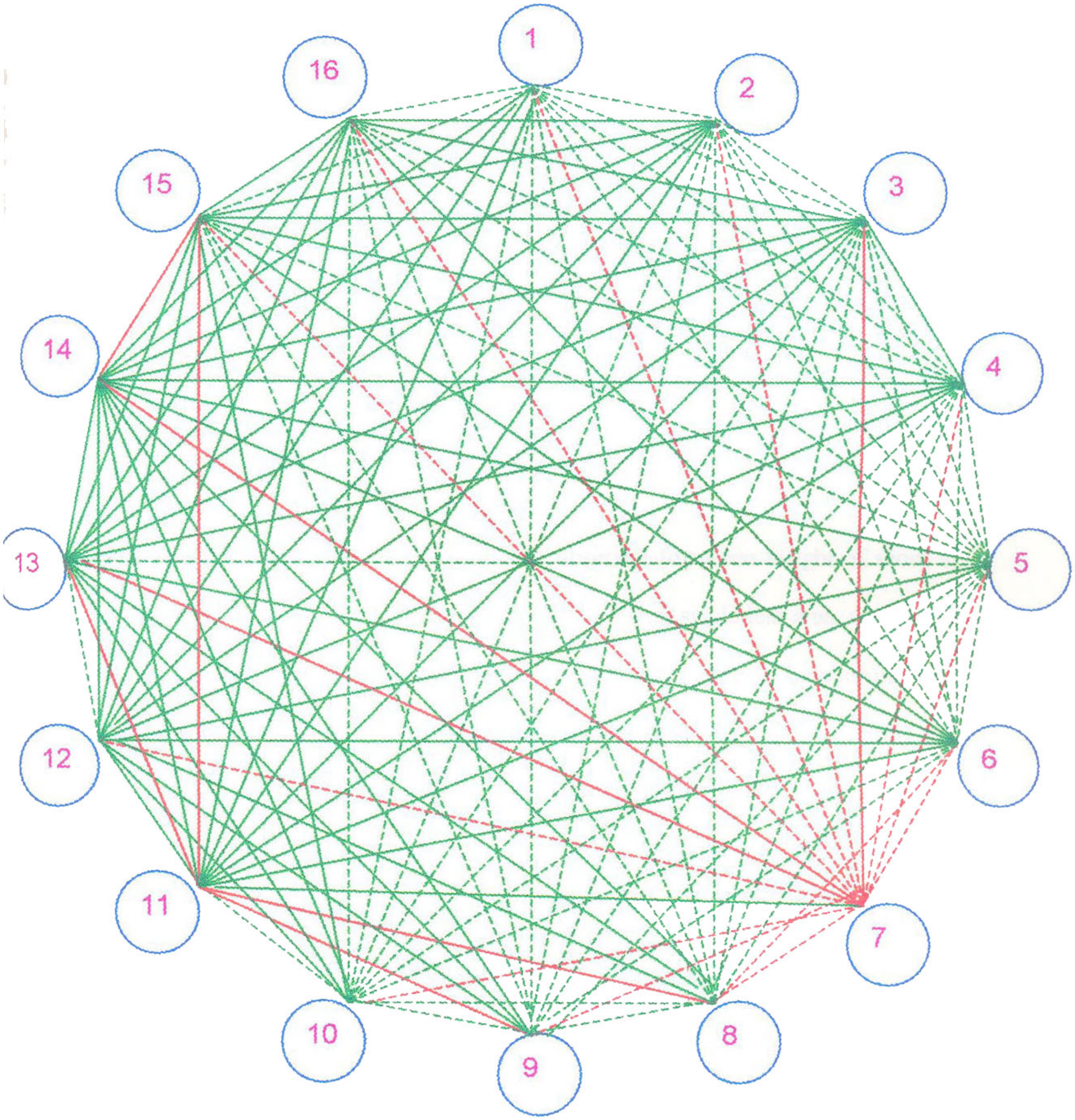
Number of branches per plant had significant and positive correlation with vine length, single leaf area, number of leaves per plant, green weight of shoot at harvest, root : shoot ratio, number of flowers per plant, number of fruits per plant and fruit yield per plant. But it recorded significant negative correlation with number of days for first flowering.

Table 4.2.4(a) Phenotypic correlation coefficient among 16 characters in ivygourd

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
X_2	0.5944**														
X_3	0.4430**	0.3559*													
X_4	0.6497**	0.4110**	0.1374												
X_5	0.7486**	0.5926**	0.3833*	0.5385**											
X_6	0.6536**	0.4683**	0.4898**	0.4319**	0.5850**										
X_7	-0.7941**	-0.6034**	-0.2954	-0.6221**	-0.6883**	-0.5181**									
X_8	0.8842**	0.5495**	0.5181**	0.6431**	0.7384**	-0.5868**	-0.8068**								
X_9	0.8875**	0.5803**	0.5284**	0.6219**	0.7529**	0.5914**	-0.7925**	0.9896**							
X_{10}	0.8390**	0.5704**	0.5520**	0.6317**	0.7081**	0.5292**	-0.7033**	0.8719**	0.8781**						
X_{11}	0.0702	0.0855	0.1536	0.1783	0.0272	0.0038	0.0406	-0.0301	-0.0355	0.4065**					
X_{12}	0.2528	0.2012	0.1827	0.2871	0.2970	0.2710	-0.3893*	0.1866	0.1534	0.2547	0.2941				
X_{13}	0.1595	0.2112	0.2003	0.1305	0.3050*	0.1835	-0.2668	0.2399	0.2197	0.1272	-0.0612	0.5007**			
X_{14}	0.1276	0.1993	0.2119	0.1893	0.1723	0.1238	-0.0875	0.1914	0.2012	0.2464	0.1446	0.1008	0.1802		
X_{15}	0.3836*	0.1717	0.2247	0.0767	0.3436*	0.2909	-0.3407*	0.4125**	0.3992**	0.2857	-0.1951	0.0493	0.1733	-0.1490	
X_{16}	0.4922**	0.1881	0.2088	0.3973**	0.4228**	0.2442	-0.4355**	0.5395**	0.5340**	0.6957**	0.2880	0.2789	0.0180	0.1294	0.2632

X_1 - Vine length (m) X_2 - Number of branches per plant X_3 - Single leaf area (cm^2) X_4 - Number of leaves per plant
X_5 - Green Weight of shoot at harvest(kg) X_6 - Root shoot ratio X_7 - Number of days for first flowering X_8 - Number of flowers per plant
X_9 - Number of fruits per plant X_{10} - Fruit yield per plant (kg) X_{11} - Single fruit weight (g) X_{12} - Single fruit size (cc)
X_{13} - Number of seeds per fruit X_{14} - Protein content in fruits (%) X_{15} - Vitamin A in fruits (IU per 100 g) X_{16} - Vitamin C in fruits (mg per 100 g)

Fig. 14 Phenotypic correlation coefficients among the characters



1) Vine length (m) (2) Number of branches per plant (3) Single leaf area (cm^2) (4) Number of leaves per (5) Green weight of shoot at harvest (kg) (6) Root : shoot ratio (7) Number of days for first flowering (8) of flowers per plant (9) Number of fruits per plant (10) Fruit yield per plant (kg) (11) Single fruit weigh (13) Number of seeds per fruit (14) Protein content in fruits (5) (15) Vitamin A in fruits (IU per 100 g) (16) Vitamin C in fruits (mg per 100 g).

Single leaf area recorded significant positive correlation with vine length, number of branches per plant, green weight of shoot at harvest, root : shoot ratio, number of flowers per plant, number of fruits per plant and fruit yield per plant. Number of leaves per plant had significant positive correlation with vine length, number of branches per plant, green weight of shoot at harvest, root : shoot ratio, number of flowers per plant, number of fruits per plant and fruit yield per plant. But it recorded significant negative correlation with number of days for first flowering.

Significant positive correlation was observed for green weight of shoot at harvest with vine length, number of branches per plant, single leaf area, number of leaves per plant, root : shoot ratio, number of flowers per plant, number of fruits per plant, fruit yield per plant, number of seeds per fruit, vitamin A in fruits and vitamin C in fruits. This character recorded significant negative correlation with number of days for first flowering.

Root : shoot ratio had significant positive correlation with vine length, number of branches per plant, single leaf area, number of leaves per plant, green weight of shoot at harvest, number of fruits per plant and fruit yield per plant. Number of days for first flowering and number of flowers per plant had negative correlation with this character. Significant negative correlation was recorded by number of days for first flowering with vine length, number of branches per plant, number of leaves per plant, green weight of shoot at harvest, root : shoot ratio, number of flowers per plant, number of fruits per plant, fruit yield per plant, single fruit size, vitamin A in fruits and vitamin C in fruits.

Number of flowers per plant had significant positive correlation with vine length, number of branches per plant, single leaf area, number of leaves per plant, green weight of shoot at harvest, root : shoot ratio, number of fruits per plant, fruit yield per plant, vitamin A in fruits and vitamin C in fruits.

Significant positive correlation was recorded for number of fruits per plant with vine length, number of branches per plant, single leaf area, number of leaves per plant, green weight of shoot at harvest, root : shoot ratio, number of flowers per plant, fruit yield per plant, vitamin A in fruits and vitamin C in fruits. But it recorded significant negative correlation with number of days for first flowering.

Fruit yield per plant had significant positive correlation with vine length, number of leaves per plant, green weight of shoot at harvest, root : shoot ratio, number of flowers per plant, number of fruits per plant, single fruit weight and vitamin C in fruits and significant negative correlation with number of days for first flowering. Single fruit weight had significant positive correlation with fruit yield per plant. Single fruit size had significant positive correlation with number of seeds per fruit. Number of seeds per fruit had positive significant correlation with green weight of shoot at harvest and single fruit size. Protein content in fruits had no significant positive or negative correlation with any of the other characters.

Significant positive correlation was recorded for vitamin A in fruits with vine length, green weight of shoot at harvest, number of flowers per plant and number of fruits per plant. It had significant negative correlation with number of days for first flowering.

Vitamin C in fruits had significant positive correlation with vine length, number of leaves per plant, green weight of shoot at harvest, number of flowers per plant, number of fruits per plant and fruit yield per plant.

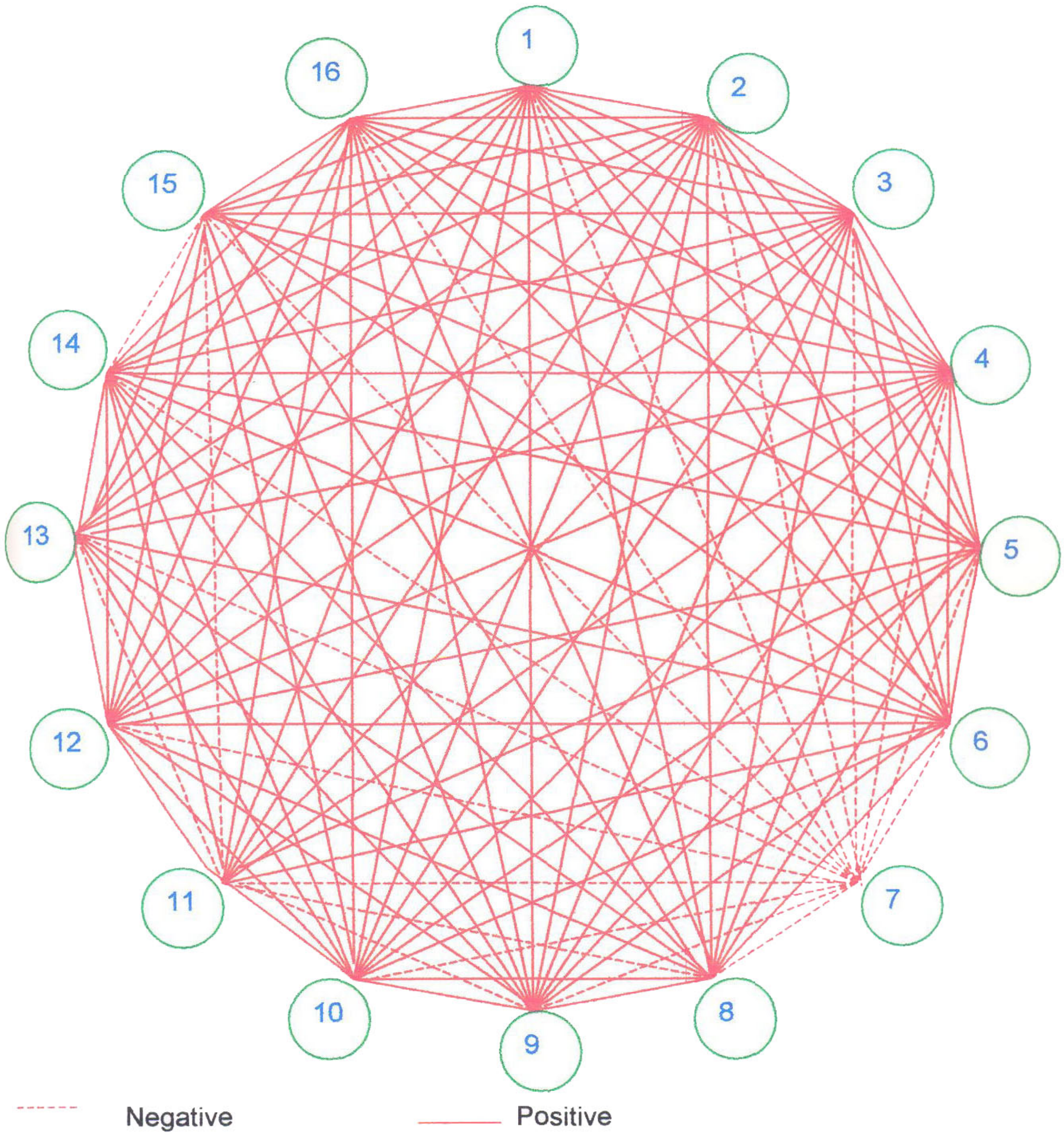
Genotypic correlation

Genotypic correlation among various characters were studied and presented in Table 4.2.4 (b) and Fig. 15 and their significance was not tested as test of significance is not available.

Vine length had high positive correlation with number of fruits per plant, number of flowers per plant, fruit yield per plant, number of branches per plant and green weight of shoot at harvest. Vine length showed high negative correlation with number of days for first flowering.

Number of branches per plant showed high positive correlation with green weight of shoot at harvest, vine length, number of fruits per plant, fruit yield per plant and number of flowers per plant. It had negative correlation with number of days for first flowering. Most of the characters had high positive correlation with this character.

Fig. 15 Genotypic correlation coefficient among 16 characters in ivygourd



1) Vine length (m) (2) Number of branches per plant (3) Single leaf area (cm^2) (4) Number of leaves per plant (5) Green weight of shoot at harvest (kg) (6) Root : shoot ratio (7) Number of days for first flowering (8) Number of flowers per plant (9) Number of fruits per plant (10) Fruit yield per plant (kg) (11) Single fruit weight (g) (13) Number of seeds per fruit (14) Protein content in fruits (5) (15) Vitamin A in fruits (IU per 100 g) (16) Vitamin C in fruits (mg per 100 g).

Table 4.2.4(b) Genotypic correlation coefficient among 16 characters in ivygourd

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
X_2	0.8623														
X_3	0.4588	0.4600													
X_4	0.6768	0.5705	0.1448												
X_5	0.8234	0.9101	0.4144	0.5832											
X_6	0.7221	0.6763	0.5170	0.4615	0.6486										
X_7	-0.8289	-0.8607	-0.3166	-0.6735	-0.7725	-0.5847									
X_8	0.8948	0.7895	0.5262	0.6634	0.7955	0.6388	-0.8471								
X_9	0.9026	0.8420	0.5340	0.6390	0.8044	0.6405	-0.8347	0.9971							
X_{10}	0.8629	0.8373	0.5674	0.6508	0.7610	0.5798	-0.7379	0.8782	0.8914						
X_{11}	0.0718	0.1219	0.1589	0.1854	0.0483	-0.0008	-0.0459	-0.0318	-0.0351	0.4149					
X_{12}	0.2664	0.2823	0.1872	0.3063	0.3170	0.3142	-0.4119	0.1904	0.1624	0.2571	0.2610				
X_{13}	0.1693	0.3854	0.2092	0.1457	0.3276	0.2162	-0.3038	0.2587	0.2253	0.1405	-0.0619	0.5542			
X_{14}	0.1302	0.3095	0.2266	0.1833	0.2015	0.1383	-0.0939	0.1952	0.2076	0.2493	0.1423	0.1094	0.1849		
X_{15}	0.3919	0.2249	0.2269	0.0804	0.3676	0.3173	-0.3571	0.4138	0.4025	0.2881	-0.1972	0.0482	0.1877	-0.1508	
X_{16}	0.5167	0.2344	0.2069	0.4154	0.4568	0.2513	-0.4679	0.5481	0.5447	0.6725	0.2958	0.2846	0.0274	0.1340	0.2626

X_1 - Vine length (m)
X_2 - Number of branches per plant
X_3 - Single leaf area (cm^2)
X_4 - Number of leaves per plant
X_5 - Green weight of shoot at harvest (kg)
X_6 - Root : shoot ratio
X_7 - Number of days for first flowering
X_8 - Number of flowers per plant
X_9 - Number of fruits per plant
X_{10} - Fruit yield per plant (kg)
X_{11} - Single fruit weight (g)
X_{12} - Single fruit size (cc)
X_{13} - Number of seeds per fruit
X_{14} - Protein content in fruits (%)
X_{15} - Vitamin A in fruits (IU per 100 g)
X_{16} - Vitamin C in fruits (mg per 100 g)

Single leaf area had high positive correlation with fruit yield per plant, number of fruits per plant, number of flowers per plant, root : shoot ratio, number of branches per plant, vine length and green weight of shoot at harvest. It was negatively correlated with number of days for first flowering.

Number of leaves per plant had high positive correlation with number of flowers per plant, fruit yield per plant, number of fruits per plant, vine length, green weight of shoot at harvest and number of branches per plant and showed negative correlation with number of days for first flowering.

High positive correlation was recorded for green weight of shoot at harvest with number of branches per plant, vine length, number of fruits per plant, number of flowers per plant, fruit yield per plant and number of leaves per plant. But green weight of shoot at harvest was negatively correlated with number of days for first flowering.

Root : shoot ratio had high positive correlation with vine length, number of branches per plant, green weight of shoot at harvest, number of fruits per plant, number of flowers per plant, fruit yield per plant and single leaf area. It was negatively correlated with number of days for first flowering and single fruit weight.

Number of days for first flowering had high negative correlation with all of the characters except single fruit weight with which it had low positive correlation.

High positive correlation was recorded for number of flowers per plant with number of fruits per plant, vine length, fruit yield per plant, green weight of shoot at harvest, number of branches per plant, root : shoot ratio and number of leaves per plant. It had high negative correlation with number of days for first flowering.

Number of fruits per plant recorded high positive correlation with number of flowers per plant, vine length, fruit yield per plant, number of branches per plant, green weight of shoot at harvest, root : shoot ratio and number of leaves per plant, while it showed high negative correlation with number of days for first flowering.

Fruit yield per plant had high positive correlation with number of fruits per plant, number of flowers per plant, vine length, number of branches per plant, green weight of shoot at harvest, number of leaves per plant, root : shoot ratio and single leaf area. Fruit yield also had high negative correlation with number of days for first flowering.

Single fruit weight and single fruit size recorded low positive correlation with all other characters. The only character which showed high positive correlation with single fruit size was number of seeds per fruit.

Number of seeds per fruit showed high correlation with single fruit size. It had negative correlation with number of days for first flowering and single fruit weight.

Protein content in fruits had low positive correlation with number of branches per plant, fruit yield per plant, single fruit weight, number of fruits per plant and green weight of shoot at harvest. But it showed negative correlation with number of days for first flowering and vitamin A content in fruits.

Vitamin A in fruits recorded positive correlation with number of flowers per plant, number of fruits per plant, vine length, green weight of shoot at harvest and root : shoot ratio. It had negative correlation with number of days for first flowering, single fruit weight and protein content in fruits.

High positive correlation was recorded for vitamin C content in fruits with fruit yield per plant, number of flowers per plant, number of fruits per plant and vine length. It had negative correlation with number of days for first flowering.

Environmental correlation

Environmental correlation coefficients are presented in Table 4.2.4 (c) and Fig 16.

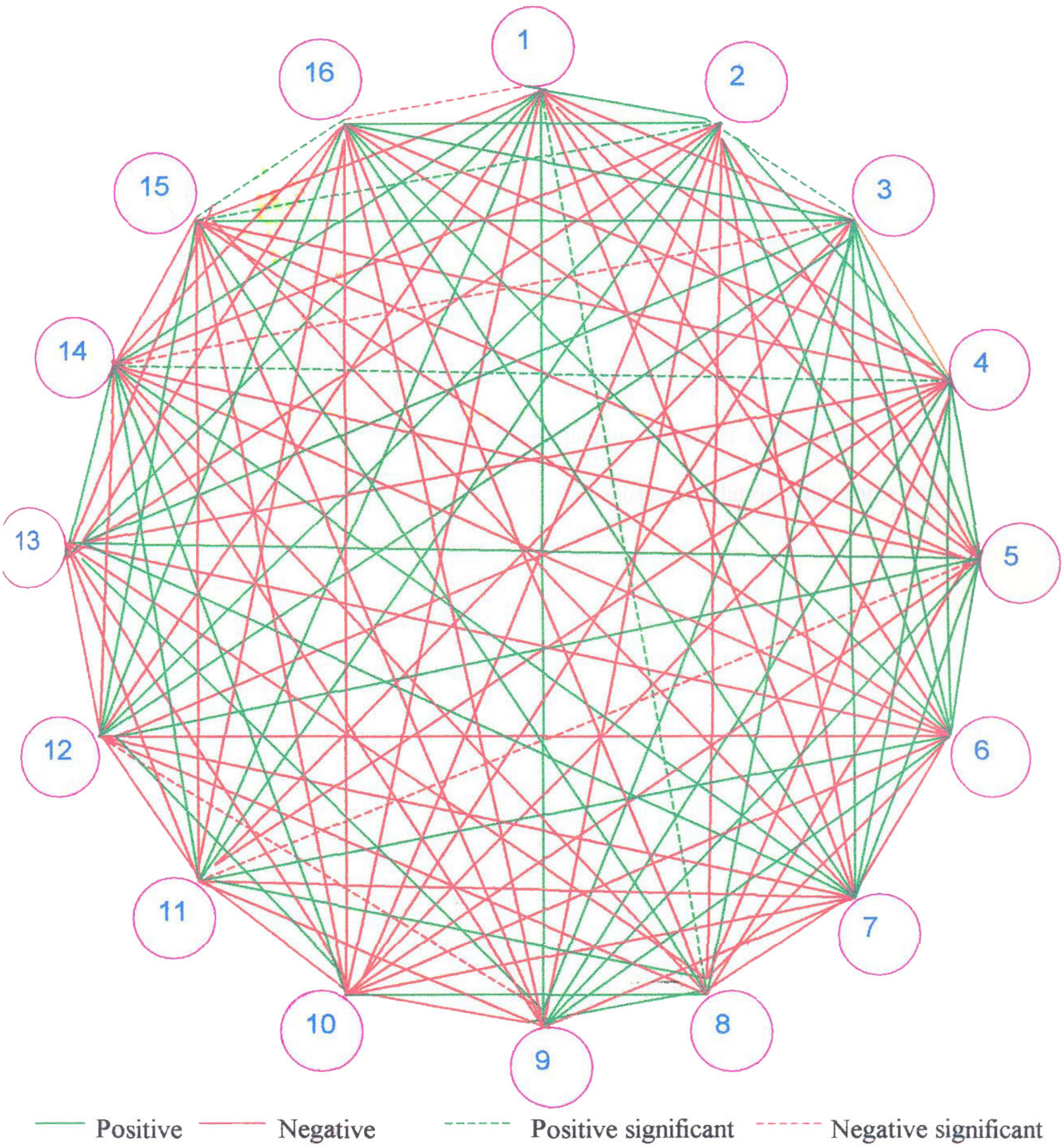
Table 4.2.4(c) Environmental correlation coefficient among 16 characters in ivygourd

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
X_2	-0.0078														
X_3	-0.0746	0.3199*													
X_4	-0.0216	0.1304	-0.0624												
X_5	-0.1657	-0.0237	0.0049	0.0611											
X_6	-0.0597	0.1073	0.2850	0.1791	0.1693										
X_7	-0.3025	-0.1270	0.0500	0.0868	0.0209	-0.0156									
X_8	0.4788**	-0.0605	0.0359	-0.2106	-0.1941	-0.1130	-0.0441								
X_9	0.2433	-0.0960	0.2674	0.0513	0.0957	0.0462	-0.0279	0.1187							
X_{10}	-0.2156	-0.1681	-0.2246	-0.0057	-0.0104	-0.0963	-0.0721	0.2081	-0.2041						
X_{11}	0.0149	0.0088	-0.0507	-0.0194	-0.3255*	0.0784	-0.0567	0.1126	-0.0659	-0.0484					
X_{12}	-0.2477	0.0494	0.0023	-0.2874	0.0603	-0.3026	-0.0151	-0.1191	-0.4028**	0.1210	-0.2673				
X_{13}	0.0567	-0.1681	0.1229	-0.0376	0.1429	-0.0296	0.0429	-0.0642	0.2654	-0.0898	-0.0727	-0.2453			
X_{14}	0.0423	-0.1295	-0.3255*	0.3615*	-0.2452	-0.0411	0.0176	-0.0520	-0.1396	0.1059	0.2367	-0.2066	0.1649		
X_{15}	-0.1561	0.3906*	0.1350	-0.1626	-0.0232	-0.1268	-0.0339	0.0959	-0.0789	-0.0369	-0.0554	0.2201	-0.1242	-0.0612	
X_{16}	-0.3839*	0.2370	0.2877	-0.1234	-0.0057	0.2496	0.1282	-0.0811	-0.0895	-0.0515	-0.0399	0.0259	-0.1404	-0.0532	0.5081*

X_1 - Vine length (m)
X_2 - Number of branches per plant
X_3 - Single leaf area (cm^2)
X_4 - Number of leaves per plant
X_5 - Green Weight of shoot at harvest (kg)
X_6 - Root : shoot ratio
X_7 - Number of days for first flowering
X_8 - Number of flowers per plant
X_9 - Number of fruits per plant
X_{10} - Fruit yield per plant (kg)
X_{11} - Single fruit weight (g)
X_{12} - Single fruit size (cc)
X_{13} - Number of seeds per fruit
X_{14} - Protein content in fruits (%)
X_{15} - Vitamin A in fruits (IU per 100 g)
X_{16} - Vitamin C in fruits (mg per 100 g)

** - *Significant at 1% level*
* - *Significant at 5% level*

Fig. 16 Environment correlation coefficients among the characters



1) Vine length (m) (2) Number of branches per plant (3) Single leaf area (cm^2) (4) Number of leaves per plant (5) Green weight of shoot at harvest (kg) (6) Root : shoot ratio (7) Number of days for first flowering (8) Number of flowers per plant (9) Number of fruits per plant (10) Fruit yield per plant (kg) (11) Single fruit weight (g) (13) Number of seeds per fruit (14) Protein content in fruits (5) (15) Vitamin A in fruits (IU per 100 g) (16) Vitamin C in fruits (mg per 100 g).

Vine length had significant positive correlation with number of flowers per plant and had significant negative correlation with vitamin C in fruits. Number of branches per plant recorded significant positive correlation with single leaf area and vitamin A in fruits. Significant positive correlation was recorded for single leaf area with number of branches per plant and significant negative correlation with protein content in fruits. Number of leaves per plant had significant positive correlation with protein content in fruits. The three characters viz., green weight of shoot at harvest, root : shoot ratio and number of days for first flowering were found not significantly and positively correlated to the other characters. Green weight of shoot at harvest showed significant negative correlation with single fruit weight.

Number of flowers per plant recorded significant positive correlation with vine length only. Significant negative correlation was recorded for number of fruits per plant and single fruit size. Fruit yield per plant was not significantly correlated with any of the characters. Single fruit weight recorded significant positive correlation with none of the characters and recorded significant negative correlation with green weight of shoot at harvest.

Single fruit size had significant negative correlation with number of fruits per plant. The two characters viz., number of seeds per fruit and protein content showed no significant correlation with any of the other characters.

Significant positive correlation was recorded for vitamin A in fruits with number of branches per plant. Vitamin C in fruits recorded significant positive correlation with vitamin A in fruits and significant negative correlation with vine length.

4.2.5 Path coefficient analysis

Path coefficient analysis was done to estimate the direct and indirect effects of vine length, number of branches per plant, single leaf area, number of leaves per plant, green weight of shoot at harvest, root : shoot ratio, number of days for first flowering, number of flowers per plant, number of fruits per plant and single fruit weight on yield. The direct and indirect effects are presented in Table 4.2.5 and Fig. 17.

Direct effect

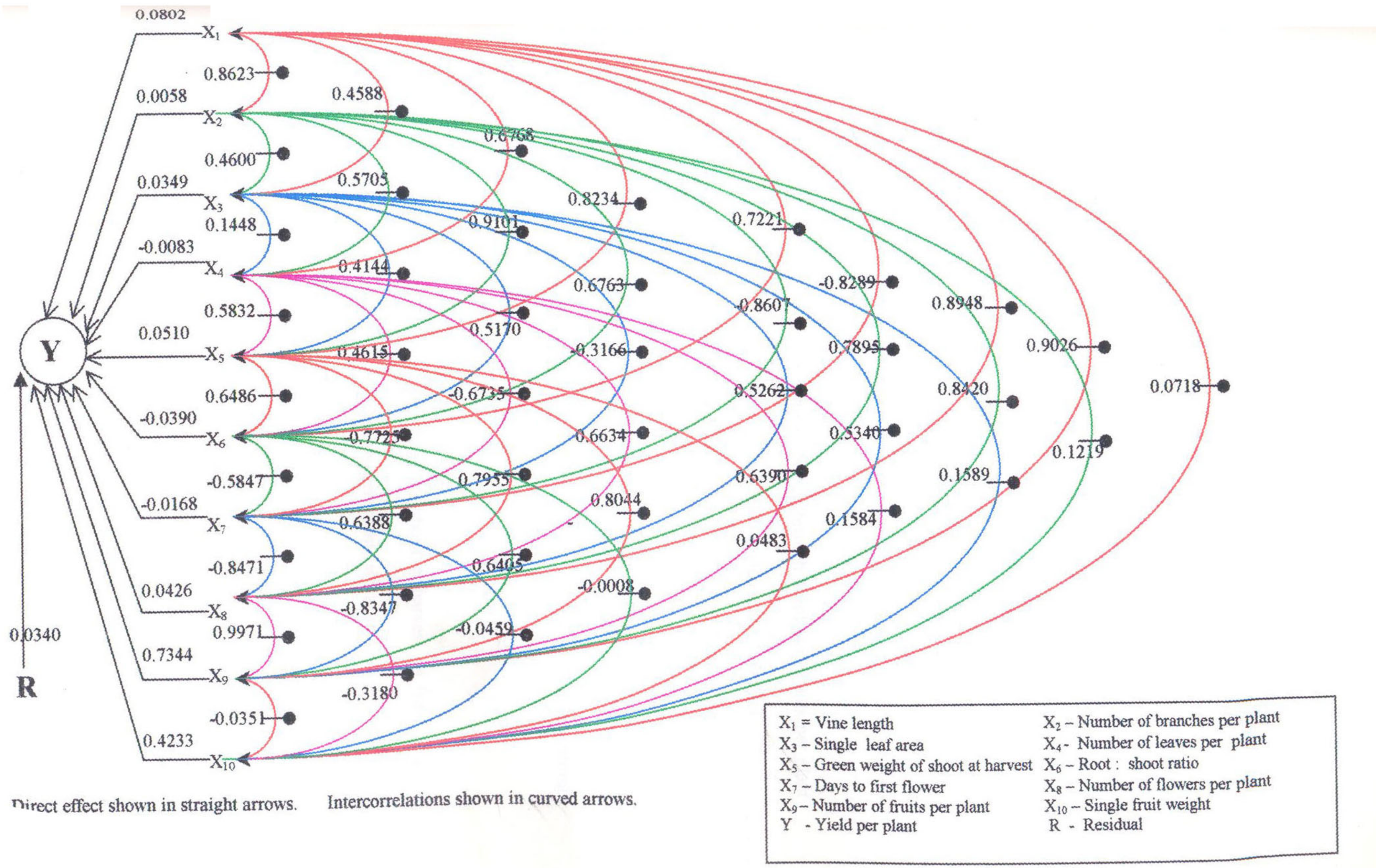
Almost all characters showed positive direct effect on fruit yield per plant excluding number of leaves per plant, root : shoot ratio and number of days for first flowering, which showed negative direct effect. Based on the classification of Lenka and Mishra (1973) the direct effect of each character was as follows. The characters such as number of fruits per plant and single fruit weight registered high direct effect and the characters such as vine length, number of branches per plant, single leaf area, green weight of shoot at harvest and number of flowers per plant recorded negligible direct effect on fruit yield per plant. Negative, negligible direct effect was recorded by number of leaves per plant, root : shoot ratio and number of days for first flowering.

Table 4.2.5 Direct and indirect effects of component characters on fruit yield per plant

Chara-cters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	Total Correlation
X_1	0.0802	0.0034	0.0155	-0.0054	0.0382	-0.0255	0.0133	0.0377	0.6518	0.0297	0.8389
X_2	0.0477	0.0058	0.0124	-0.0034	0.0302	-0.0182	0.0101	0.0234	0.4262	0.0362	0.5704
X_3	0.0355	0.0021	0.0349	-0.0011	0.0195	-0.0191	0.0050	0.0221	0.3881	0.0650	0.5520
X_4	0.0521	0.0024	0.0048	-0.0083	0.0275	-0.0168	0.0105	0.0274	0.4568	0.0755	0.6319
X_5	0.0600	0.0034	0.0134	-0.0045	0.0510	-0.0228	0.0116	0.0315	0.5530	0.0115	0.7081
X_6	0.0524	0.0027	0.0171	-0.0036	0.0298	-0.0390	0.0087	0.0250	0.4344	0.0016	0.5291
X_7	-0.0637	-0.0035	-0.0103	0.0052	-0.0351	0.0202	-0.0168	-0.0344	-0.5820	0.0172	-0.7032
X_8	0.0709	0.0032	0.0181	0.0053	0.0376	-0.0228	0.0136	0.0426	0.7268	-0.0127	0.8736
X_9	0.0712	0.0034	0.0185	0.0052	0.0384	-0.0230	0.0133	0.0422	0.7344	-0.0150	0.8886
X_{10}	0.0056	0.0005	0.0054	0.0015	0.0014	-0.0001	-0.0007	-0.0013	-0.0261	0.4233	0.4095

Residual effect :: 0.034
Direct effects :: Diagonal elements
Indirect effects :: Off diagonal elements

X_1 - Vine length (m)
X_2 - Number of branches per plant
X_3 - Single leaf area (cm^2)
X_4 - Number of leaves per plant
X_5 - Green weight of shoot at harvest (kg)
X_6 - Root : shoot ratio
X_7 - Number of days for first flowering
X_8 - Number of flowers per plant
X_9 - Number of fruits per plant
X_{10} - Single fruit weight (g)



Direct effect shown in straight arrows. Intercorrelations shown in curved arrows.

Indirect effect

Vine length had high indirect effect on fruit yield per plant through number of fruits per plant. Vine length exerted negligible indirect effect through all other characters.

Number of branches per plant had high indirect effect on fruit yield per plant through number of fruits per plant, while the indirect effects of number of branches per plant through all other characters were negligible.

Single leaf area had high indirect effect through number of fruits per plant and negligible indirect effect through the remaining characters, on fruit yield per plant.

Number of leaves per plant registered high indirect effect on fruit yield per plant through number of fruits per plant. It had negligible indirect effect through the remaining characters.

The indirect effect of green weight of shoot at harvest on fruit yield per plant was high through number of fruits per plant, while its indirect effect was negligible through all other characters.

VARIETIES - FIELD VIEW

PLATE 4A

PLATE 4B

PLATE 4C

PLATE 4D

Root : shoot ratio, like other characters had high indirect effect on fruit yield per plant through number of fruits per plant and had negligible indirect effect through the remaining characters.

The only one character which showed high negative indirect effect on fruit yield per plant was number of days for first flowering, which was also through number of fruits per plant. It had negligible indirect effect through the remaining characters.

Number of flowers per plant had high indirect effect on fruit yield per plant through number of fruits per plant. It had negligible indirect effect through the remaining characters.

Number of fruits per plant had negligible indirect effect on fruit yield per plant through all other characters.

The indirect effect of single fruit weight on fruit yield per plant was negligible through all other characters.

About 96.6 per cent of variation in fruit yield per plant was attributed to the influence of the above ten component characters.

4.2.6 Selection index

Discriminent function technique was adopted to identify superior genotypes for fruit yield per plant and the component characters viz., vine length, single leaf area, number of leaves per plant, green weight of shoot at harvest, root : shoot ratio, number of days for first flower opening, number of flowers per plant, number of fruits per plant, average fruit weight, size of fruits, number of seeds per fruit, protein content in fruits, vitamin A content of fruits and vitamin C in fruits.

The component characters showed relatively stronger association with yield and can form a valuable selection index for yield in this crop. The index values for each variety is determined and the varieties were ranked accordingly. The selection indices are presented in Table 4.2.6. The highest index value was recorded by the treatment T_{36} followed by T_{30}, T_{37}, T_{34} and T_{21}. These five top ranking varieties were identified to be genetically superior genotypes.

VARIETIES - FIELD VIEW

PLATE 5A

PLATE 5B

PLATE 5C

PLATE 5D

Table 4.2.6 Selection indices arranged in descending order

Sl. No.	Genotypes	Selection index values
1	T_{36}	11280.62
2	T_{30}	10777.84
3	T_{37}	10028.88
4	T_{34}	9822.01
5	T_{21}	9650.65
6	T_{38}	9282.46
7	T_{2}	8378.91
8	T_{11}	8243.46
9	T_{40}	8075.31
10	T_{9}	7602.36
11	T_{28}	7579.16
12	T_{12}	7215.84
13	T_{39}	6938.79
14	T_{24}	6774.84
15	T_{7}	6721.03
16	T_{35}	6679.01
17	T_{10}	6655.82
18	T_{16}	6638.82
19	T_{6}	6629.01
20	T_{27}	6302.26
21	T_{14}	6287.08
22	T_{23}	5944.23
23	T_{5}	5860.12
24	T_{25}	5841.46
25	T_{4}	5783.41
26	T_{31}	5724.53
27	T_{8}	5648.19
28	T_{33}	5620.80
29	T_{19}	5570.25
30	T_{26}	5557.48
31	T_{13}	5511.74
32	T_{17}	5031.68
33	T_{22}	4817.48
34	T_{29}	4732.78
35	T_{3}	4655.99
36	T_{15}	4588.55
37	T_{20}	4076.62
38	T_{1}	3997.85
39	T_{18}	3967.57
40	T_{32}	3020.92

DISCUSSION

5. DISCUSSION

Genetic improvement of a crop demands a thorough understanding of the genetic basis of yield and yield components of that particular crop. The variability present in the population, heritability and genetic advance are to be essentially estimated. The way in which different characters are correlated and their effect on yield are also important. Variations in a population arise due to the differences in the genetic make up of the individuals or the environment in which they are grown. Selection is effective when there is considerable genetic variability among the individuals of a population. The present study to assess the genetic divergence and genetic parameters is conducted as two experiments. Results of the present investigation, which is aimed at gathering information in this regard, are discussed below.

Experiment No.I

An assessment of genetic diversity is of much importance in plant breeding research as far as the selection of parents for hybridisation is concerned. The economic value of a plant is determined by several characters which may be correlated. Mahalanobis D^2 – statistics gives a quantitative measure of divergence based on multiple characters. The fifty genotypes are clustered into 11 groups. The Fig. 1 shows the genetic diversity at intra and intercluster levels. The greater the distance between two clusters the greater is the divergence between genotypes belonging to the two clusters. The genotypes within a cluster are less divergent than those which are in different clusters. In the selection of parents for hybridization three points mainly need to be considered. They are the relative contribution of each character to the total divergence, choice of the clusters with maximum genetic distance and selection of genotypes from such clusters.

Among the 11 clusters maximum number of genotypes were included in the Cluster III followed by Cluster IV and V. Five genotypes T_{19}, T_{21}, T_{43}, T_{44} and T_{49} did not come under any of the clusters. The maximum intercluster distance was between Cluster II and Cluster IX (2156.75) and the minimum intercluster distance was between Cluster VIII and Cluster XI. The Cluster IX which include only one line which is a male line T_{43} is found to have maximum intercluster distance with seven of the 11 clusters formed (Fig. 2). This is followed by Cluster II containing the male lines T_5, T_8 and T_{25} and female lines T_7, T_{10} and T_{27} kept maximum divergence between four of the 11 clusters.

So selection of parents from these divergent clusters will be very effective in hybridisation. The crosses of the combinations T_7 x T_{43}, T_{10} x T_{43} and T_{27} x T_{43} would be promising. These crosses may yield better hybrids. Character-wise performance at cluster level is seen from Fig. 3, 4, 5, 6, 7, 8, 9 and 10. Number of flowers per plant registered the maximum coefficient of variation (32.20 per cent) followed by number of leaves (19.10 per cent) at genotypic level. So number of flowers and leaves per plant are the two characters which contribute maximum for the divergence of the genotypes and can be considered as potential contributors of differentiation.

Experiment No.II

Variability

Forty genotypes of ivygourd showing variations in different morphological characters, collected from different regions of Karnataka, Tamil Nadu, Andhra Pradesh and Kerala were evaluated using R.B.D. with sufficient replications. In the present study analysis of variance showed significant differences for all the characters under study. This indicated wide range of differences between the genotypes for all these characters. It is important to know whether this variability is due to genotype or environment. Hence phenotypic, genotypic and environmental variances were estimated.

The average vine length has been estimated as 1.79 m with a range of 1.08 m to 2.75 m. PCV and GCV were in the medium range (20-30 per cent). Environmental variance was negligible indicating a low influence of environment on this character. This result was in conformity with the reports of Thakur *et al.* (1994) and Katiyar *et al.* (1996) on bittergourd; Mathew (1999) on bottlegourd; Ram *et al.* (1996) on cucumber and Borthakur and Shadeque (1990) on pumpkin. The average number of branches per plant was observed to be 3.88 with a range of 2.50 to 6.50. High PCV and moderate GCV were exhibited by this character. Environmental variance was also less. These findings were in consonance with the findings of Thakur *et al.* (1994) in bittergourd; Menon (1998) in pointedgourd; Mathew (1999) in bottlegourd and Abusaleha and Dutta (1990) and Prasad and Singh (1992) in cucumber.

The single leaf area had an average of 51.17 cm^2, ranging from 32.55 cm^2 to 85. 50 cm^2. PCV and GCV were moderate. Low environmental variance was recorded. Similar results were reported by Singh *et al.* (1992) on pointedgourd and Solanki and Seth (1980), Abusaleha and Dutta (1990) and Prasad and Singh (1992) on cucumber. The average number of leaves per plant was 253.81 with a range of 170.50 to 342.00. Moderate PCV and GCV were also recorded. Environmental variance was less. This was in agreement with the findings of Singh *et al.* (1992) in pointedgourd; George (1981) in ashgourd; Abusaleha and Dutta (1990) and Prasad and Singh (1992) in cucumber and Borthakur and Shadeque (1990) and Sirohi (1994) in pumpkin.

The average weight of shoot at harvest and root : shoot ratio were 1.181 kg and 0.21 respectively. High PCV and GCV were recorded by both of these characters. Environmental variance was negligible for these characters. These findings were in conformity with the findings of Varghese and Rajan (1993) in snakegourd; Thakur *et al.* (1994) in bittergourd; Khanikar *et al.* (1996) in ridgegourd; Mathew (1999) in bottlegourd and Abusaleha and Dutta (1990) and Prasad and Singh (1992) in cucumber.

The average number of days for flowering was 83.54 days with a minimum of 58.00 days and a maximum of 108.50 days. Environmental variance was less and the least PCV and GCV was recorded by this character. This finding was in tune with the findings of Vahab (1989) in bittergourd; Varghese (1991) in snakegourd; Mathew (1999) in bottlegourd and KAU (1996); Ram *et al.* (1996) and Gayathri (1997) in cucumber. The average number of flowers per plant was

1362.83, ranging from 562.20 to 2429.20. Next to fruit yield per plant, number of flowers per plant recorded the maximum variability, both at phenotypic and genotypic level. This result was in conformity with the experimental results of Hamid *et al.* (1989) in ashgourd; Varghese and Rajan (1993) in snakegourd; Singh *et al.* (1992) in pointedgourd; Thakur *et al.* (1994) in bittergourd and Sirohi (1994) in pumpkin.

The yield governing character, number of fruits per plant had an average of 993.94 with a range of 418.00 to 1734.00. Very high PCV and GCV was recorded by this character. This finding was in consonance with the findings of Varalakshmi *et al.* (1995) in ridgegourd; Kumar *et al.* (1999) and Mathew (1999) in bottlegourd; Radhika (1999) in snakegourd; Kumaran *et al.* (1997) and Mohanty and Mishra ((1999) in pumpkin and Ram *et al.* (1996) and Wehner and Cramer (1996) in cucumber.

The most important economic character fruit yield per plant was 12.82 kg on an average with a range of 7.16 kg to 24.04 kg. Fruit yield per plant recorded the maximum variability (PCV and GCV) among all the characters studied. Environmental variance was also very less. These results were in agreement with the findings of Katiyar *et al.* (1996) and Iswaraprasad (2000) in bittergourd; Khanikar *et al.* (1996) in ridgegourd; Kumar *et al.* (1999) and Mathew (1999) in bottlegourd; Radhika (1999) and Ashok (2000) in snakegourd; Menon (1998) in pointedgourd; Anon (1996) and Gayathri (1997) in cucumber and Sirohi (1994) and Mohanty and Mishra (1999) in pumpkin.

The single fruit weight ranged between 8.95 g and 16.57 g with an average of 12.34 g. Moderate PCV and GCV were recorded for this character and the environmental variability was less. This result was in conformity with the experimental results of Raju and Peter (1995) in ivygourd; Vahab (1989), Jaiswal *et al.* (1990) and Iswaraprasad (2000) in bittergourd; Hamid *et al.* (1989) in ashgourd; Varalakshmi *et al.* (1995) in ridgegourd and Ram *et al.* (1996) and Wehner and Cramer (1996) in cucumber. The average single fruit size was 20.68 c.c. with a range of 11.00 c.c to 28.50 c.c. PCV and GCV were moderate and environmental variance was very less for fruit size. Similar findings were reported by Raju and Peter (1995) on ivygourd; Jaiswal *et al.* (1990) and Iswaraprasad (2000) in bittergourd; Mathew (1999) and Bisognin and Storck (2000) in bottlegourd and Ram *et al.* (1996) and Wehner and Cramer (1996) in cucumber.

The average number of seeds per fruit was 77.87. It ranged from 51.50 to 116.50. Variability at phenotypic and genotypic levels were high and environmental variability was low. This finding was in tune with the findings of Sarkar *et al.* (1990) in pointedgourd; Varghese (1991) and Ashok (2000) in snakegourd; Varalakshmi *et al.* (1995) in ridgegourd; Iswaraprasad (2000) in bittergourd and Mariappan and Pappiah (1990) in cucumber.

Protein content in fruits ranged between 1.70 per cent and 2.90 per cent with an average of 2.34 per cent. Moderate variability was recorded both at phenotypic and genotypic levels. Similar results were obtained by Ramachandran and Gopalakrishnan (1980) and Jaiswal *et al.* (1990) in bittergourd; George

(1981) in ashgourd and Rahman *et al.* (1994) in bottlegourd. Average Vitamin A and Vitamin C content in fruits were 208.53 IU and 23.79 mg respectively per 100 gm of the fruit. PCV and GCV recorded were moderate for both of these characters. Environmental variability was very less. These findings were in consonance with the findings of Ramachandran and Gopalakrishnan (1980) and Jaiswal *et al.* (1990) in bittergourd; George (1981) in ashgourd and Rahman *et al.* (1994) in bottlegourd.

Heritability and genetic advance

The success of improvement of the characters under study depends on the heritability (broad sense) of the character and expected genotypic advance under selection. Heritability coefficient gives an idea about the relative importance of the genetic and environmental components of variance in the character expression. High values of these coefficients indicate the effectiveness in the selection of phenotypically superior plants in the next generation. Similarly, the magnitude of improvement in the performance of selected individuals over the population assumes importance. This is estimated through the parameter genetic advance. For easy understanding heritability is classified as high (60 to 100), moderate (30 – 60) and low (<30) and genetic advance as high (>20), moderate (10-20) and low (<10).

Heritability along with genetic advance is more useful than heritability alone in predicting the resultant effect of selecting the best individuals (Johnson *et al.*, 1955). Fig. 13 shows the distribution of characters in terms of heritability (H^2)

and genetic advance (G.A). Among the different characters maximum heritability estimate was for Vitamin A in fruits followed by number of flowers and fruits per plant and fruit yield per plant. If five per cent selection is to be practised maximum genetic advance is expected for fruit yield per plant followed by number of flowers and fruits per plant, and minimum by number of days for first flowering. Comparison of the improvements expected from these characters are seen from Fig. 13. According to Panse and Sukhatme (1957), the characters with high heritability and genetic advance were controlled by additive gene action and therefore amenable to genetic improvement through selection. In the present study all of the economic characters recorded very high heritability (>95 per cent) followed by genetic advance. So selection of phenotypically superior plants with respect to these characters will result in a significant improvement in the next generation.

High heritability along with high genetic advance as percentage of mean for the major characters under study were formerly reported by Joseph (1999) on ivygourd; Varalakshmi *et al.* (1995) and Anitha (1998) on ridgegourd; Rajput *et al.* (1996) and Iswaraprasad (2000) on bittergourd; Menon (1998) on ashgourd; Kumar *et al.* (1999) and Mathew (1999) on bottlegourd; Mathew and Khader (1999) and Radhika (1999) on snakegourd; Gayathri (1997) on cucumber and Rajendran and Thamburaj (1994), Gopal *et al.* (1996) and Deepthy (2000) on watermelon.

Correlation

The degree and direction of the inherent association (genotypic correlation) of characters apart from the observable correlation (phenotypic correlation) between two characters are important for the simultaneous selection of characters for genetic improvement. Correlation coefficients gives an idea about the mutual relationship between various plant characters and determines the component characters on which selection can be based for genetic improvement in yield. The presence of genotypic correlation may be either due to pleiotropic action of genes or due to linkage or more likely both. If a positive genotypic correlation was observed for a pair of characters, certainly the improvement in one character will improve the other character also, thus helping a breeder to select characters on the correlated response to selection. If the improvement in one character results a decrease in other character, this will also help the breeder in the selection of characters if necessary. The significant pair-wise correlations are seen in Fig. 14, 15 and 16.

Fruit yield per plant had high positive genotypic and significant positive phenotypic correlation with number of fruits per plant, average fruit weight, number of flowers per plant, vine length, number of leaves per plant and root : shoot ratio. It had significant environmental correlation with none of the characters. This finding was in tune with the findings of Joseph (1999) and Sarnaik *et al.* (1999) in ivygourd; Rajput *et al.* (1995) in bittergourd; Anitha (1998) and Rao *et al.* (2000) in ridgegourd; Sarkar *et al.* (1999) in pointedgourd and Neikov *et al.* (1995), Saikia *et al.* (1995) and Gayathri (1997) in cucumber.

Vine length had high positive genotypic correlation and significant positive phenotypic correlation with number of branches per plant, green weight of shoot at harvest, number of flowers per plant, number of fruits per plant and fruit yield per plant. It had significant positive environmental correlation with only number of flowers per plant. This is in conformity with the findings of Anitha (1998) in ridgegourd; Menon (1998) in pointedgourd and Satyanarayana (1991), Prasad and Singh (1992) and Ma *et al.* (1995) in cucumber. Contrary to this finding Shibukumar (1995) reported with regard to the findings in watermelon negative correlation between vine length and yield per plant. Higher genotypic correlation indicates the strong association of these characters.

Number of branches had significant positive phenotypic and high positive genotypic correlation with vine length, green weight of shoot at harvest, number of flowers per plant, number of fruits per plant and fruit yield per plant. This character also showed significant positive environmental correlation with single leaf area and vitamin A content in fruits. Similar results were reported by Sarnaik *et al.* (1999) on ivygourd; Anitha (1998) and Rao *et al.* (2000) on ridgegourd; Sarkar *et al.* (1999) on pointedgourd and Rajput *et al.* (1991) and Saika *et al.* (1995) on cucumber.

Significant positive phenotypic correlation and high positive genotypic correlation was observed for single leaf area with fruit yield per plant, number of fruits per plant, number of flowers per plant, vine length and number of branches per plant. It also had significant positive environmental correlation with number of branches per plant. This was in agreement with the findings of Rajput *et al.*

(1995) in bittergourd and Saika *et al.* (1995) in cucumber. Number of leaves per plant had high positive genotypic correlation and significant positive phenotypic correlation with vine length, number of branches per plant, number of flowers per plant, number of fruits per plant and fruit yield per plant. This was in tune with the reports of Rajput *et al.* (1995) on bittergourd; Menon (1998) on ashgourd; Saika *et al.* (1995) on cucumber and Borthakur and Shadeque (1990) on pumpkin. However, a negative correlation of number of leaves per plant with yield was reported by Gwanama *et al.* (1998) on watermelon.

Green weight of shoot at harvest and root : shoot ratio had high genotypic correlation with vine length, number of branches per plant, number of flowers per plant, number of fruits per plant and fruit yield per plant. Both of these characters had no significant environmental correlation with any of the characters.

Number of days for flowering recorded negative phenotypic, genotypic and environmental correlation with all other characters. This was in conformity with the findings of Prasad and Singh (1990) in pointedgourd; Rajput *et al.* (1995) in bittergourd; Rao *et al.* (2000) in ridgegourd; Satyanarayana (1991) and Damarany *et al.* (1995) in cucumber and Shibukumar (1995) in watermelon.

Number of flowers per plant had high genotypic correlation and significant positive phenotypic correlation with vine length, number of branches per plant, green weight of shoot at harvest, number of fruits per plant and fruit yield per plant. It had significant positive environmental correlation with vine length only. This was in tune with the findings of Menon (1998) in ashgourd; Chen *et al.*

(1994) and Neikov *et al.* (1995) in cucumber; Borthakur and Shadeque (1990) in pumpkin and Gopal *et al.* (1996) in watermelon.

Number of fruits per plant had high genotypic correlation and significant positive phenotypic correlation with number of flowers per plant, fruit yield per plant, vine length, number of branches per plant and green weight of shoot at harvest. It had no significant positive environmental correlation with other characters. This was in conformity with the findings of Joseph (1999) and Sarnaik *et al.* (1999) in ivygourd; Anitha (1998) and Rao *et al.* (2000) in ridgegourd; Menon (1998) in ashgourd; Ashok (2000) in snakegourd; Ma *et al.* (1995), Gayathri (1997) and Zhang *et al.* (1999) in cucumber; Borthakur and Shadeque (1990) in pumpkin and Shibukumar (1995) and Saika *et al.* (1995) in watermelon.

Single fruit weight had low genotypic correlation and significant positive phenotypic correlation with fruit yield per plant. Environmental correlation also was very low for this character with other characters. Similarly, fruit size had also low genotypic, phenotypic and environmental correlation with other economically important characters. This was in conformity with the experimental results of Milotary *et al.* (1991) in cucumber and Gwanama *et al.* (1998) in watermelon. Contrary to this finding, many scientists reported high phenotypic and genotypic correlations of this characters with yield.

Number of seeds per fruit had high genotypic correlation and significant positive phenotypic correlation with fruit size only. No significant environmental correlation was recorded by number of seeds per fruit with any of the characters.

Similar results were reported by Prasad and Singh (1990) on pointedgourd; Milotary *et al.* (1991) on cucumber and Kumaran *et al.* (1998) and Devadas *et al.* (1999) on pumpkin. But contrary to this negative genotypic and phenotypic correlation of these characters were reported by Sidhu and Brar (1981) in bittergourd.

Protein content in fruits had low genotypic correlation with number of fruits per plant, single fruit weight and fruit yield per plant whereas no phenotypic and environmental correlations were recorded for this character with any of the other characters. Vitamin A and Vitamin C in fruits had no significant correlation with any of the fruit characters and had positive correlations with morphological characters such as vine length, green weight of shoot at harvest, number of flowers per plant and number of fruits per plant.

In the present study all pairs of characters exhibited genotypic correlation coefficients higher than phenotypic correlation coefficients. Environmental correlations are absent for almost all pairs of characters except for a very few pairs. The results indicated that there is strong association between all pairs of characters genetically, but the phenotypic value is lessened by the significant interaction of environment.

Path Coefficient Analysis

The technique of path analysis was applied in plant selection by Dewey and Lu (1959). It measures the direct and indirect contribution of independent variables on dependent variable and the residual effects. This technique also provides information about the cause and effect situation and helps in understanding the cause of association between two variables. Direct effects and indirect effects can be 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)). Path analysis was done taking the characters vine length, number of branches per plant, single leaf area, number of leaves per plant, green weight of shoot at harvest, root : shoot ratio, number of days for first flowering, number of flowers per plant, number of fruits per plant and single fruit weight as independent variables which had strong genotypic correlation with fruit yield per plant, the dependent variable.

In the present study, majority of the characters recorded positive direct and indirect effects. Among different characters, contributing to yield, number of fruits per plant had the maximum direct effect. Similar results were reported by Paranjape and Rajput (1995) on bittergourd; Menon (1998) and Rao *et al.* (2000) on ashgourd; Chen *et al.* (1994) and Gayathri (1997) on cucumber and Shibukumar (1995) on watermelon. The high genotypic correlation showed by number of fruits per plant with fruit yield per plant was also due to the positive indirect effect (although negligible) through all of the remaining characters. This was in conformity with the findings of Paranjape and Rajput (1995) in bittergourd; Rao *et al.* (2000) in ashgourd and Singh and Singh (1988) in watermelon.

Next to number of fruits per plant, average single fruit weight had high positive direct effect on fruit yield per plant. This finding was in agreement with the findings of Paranjape and Rajput (1995) in bittergourd; Menon (1998) and Rao *et al.* (2000) in ashgourd; Prasad and Singh (1992), Chen *at al.*, (1994) and Saika *et al.* (1995) in cucumber; Shibukumar (1995) in watermelon and Dhaliwal (1996) in muskmelon. But Solanki and Shah (1992) reported on cucumber moderate direct effect for average fruit weight on fruit yield. Single fruit weight exerted negligible indirect effect through all other characters. This was in conformity with the findings of Abusaleha and Dutta (1988) and Prasad and Singh (1992) in cucumber and Rajendran and Thamburaj (1989) in watermelon. High correlation of single fruit weight with fruit yield per plant was due to the high direct effect and cumulative indirect effect through the remaining characters. So direct selection for this trait will be rewarding for yield improvement.

Vine length and number of branches per plant showed negligible direct effect on fruit yield per plant. Both of them exerted high indirect effect on fruit yield through number of fruits per plant. Similar results were reported by Ramachandran (1978) and Paranjape and Rajput (1995) on bittergourd and Abusaleha and Dutta (1988), Prassunna and Rao (1988) and Solanki and Shah (1992) on cucumber. But contrary to this Rajput *et al.* (1991) and Prasad and Singh (1992) reported negative indirect effect on cucumber. Even though vine length and number of branches per plant had low direct effects on yield, their total correlation was high due to high indirect effect through number of fruits per plant.

Single leaf area, green weight of shoot at harvest and number of flowers per plant registered negligible direct effect and high indirect effect through number of fruits per plant on fruit yield per plant. High indirect effect reported by single leaf area on yield was in conformity with the experimental results of Pynadath (1978) in snakegourd; Paranjape and Rajput (1995) in bittergourd and Rajendran and Thamburaj (1989) in watermelon. But Menon (1998) reported on ashgourd high direct effect of single leaf area on yield. As far as number of flowers per plant is concerned, many scientists reported high direct effect on yield (Paranjape and Rajput (1995) in bittergourd; Menon (1998) in ashgourd; Choudhary and Mandal (1987), Solanki and Shah (1992) and Chen *et al.* (1994) in cucumber and Dhaliwal (1996) in muskmelon). The high correlation exhibited by single leaf area, green weight of shoot at harvest and number of flowers per plant with yield is mainly due to their indirect effects through number of fruits per plant and not due to their direct effects. So indirect selection through number of fruits per plant will be effective in yield improvement.

Number of days for first flower opening had negative negligible direct effect and high negative indirect effect on fruit yield per plant. Negative indirect effect of number of days for flowering on yield was formerly reported by Pynadath (1978) on snakegourd; Singh and Singh (1988) and Rajendran and Thamburaj (1989) on watermelon and Prasad and Singh (1992) on cucumber. But Abusaleha and Dutta (1988), Pandita *et al.* (1990) and Rao *et al.* (2000) reported high negative direct effect of number of days for flowering on fruit yield per plant with regard to cucumber, roundmelon and ridgegourd respectively. The high negative correlation recorded by days to first flower opening on yield may be due to its negative direct and indirect effects. So selection may be practised in the opposite direction for this character.

Number of leaves per plant and root : shoot ratio registered negative negligible direct effect on fruit yield per plant. Both of these characters had high indirect effect on fruit yield per plant through number of fruits per plant. This was in conformity with the experimental results of Paranjape and Rajput (1995) in bittergourd; Menon (1998) in ashgourd and Rajendran and Thamburaj (1989) in watermelon.

High correlation of component characters and negligible residue effect indicates the efficiency of selection based on these characters and the little influence of other component characters on fruit yield per plant.

Selection Index

Selection of genotypes based on a suitable index is highly efficient in any breeding programme. An estimation of discriminent function based on reliable and effective characters is a valuable tool for the practical plant breeder. In the present study selection index for the genotypes was computed on the sixteen characters namely vine length, single leaf area, number of leaves per plant, weight of shoot at harvest, root : shoot ration, number of days to flower, number of flowers per plant, number of fruits per plant, average fruit weight, size of fruits, fruit yield per plant, number of seeds per fruit, protein content in fruits, vitamin A in fruits and vitamin C content of fruits.

Based on the selection index values, the top ranking five genotypes viz., Alappuzha local, Kanjangad local, Thirunelli local, Mancheswaram local and

Nangikadapuram local, with the highest scores were identified to be genetically superior from other varieties.

The characters number of fruits per plant and average fruit weight can be used as a criteria for selection of genotypes since they are found to have high direct effect on yield of the plant. There is a high scope of improvement for yield through selection since there exists high variation for these characters and it has high heritability and genetic advance.

SUMMARY

6. SUMMARY

The present study was conducted at the Department of Plant Breeding and Genetics, College of Agriculture, Vellayani during the period 1999-2001. The study was conducted with the objective of estimating the genetic divergence and the factors contributing to genetic divergence, the role of genetic constitution in the expression of the characters, direct and indirect effects of various traits influencing yield and formulation of a selection index to identify superior genotypes. The data for the study were collected from two field experiments.

In Experiment I, 50 local cultivars of ivygourd collected from different localities were raised in randomised block design with three replications. Observations were recorded on characters such as vine length, number of branches per plant, leaf area, number of leaves per plant, green weight of shot at harvest, root : shoot ratio, days to first flower opening and number of flowers per plant. The data collected were subjected to Mahalanobis D^2 analysis and the genotypes were clustered into 11 groups. Maximum genotypes (11) were included in the cluster III followed by cluster IV (10), cluster V (9), Cluster I (7), cluster II (6) and cluster VI (2). Clusters VII, VIII, IX, X and XI had only one genotype each.

Maximum divergence was shown between the clusters II and IX, while it is minimum between VIII and XI. The three superior crosses which may yield better hybrids were Balthangadi local I (T_7) x Pilangatta local II (T_{43}), Bandargram

local I (T_{10}) x Pilangatta local II (T_{43}) and Seethambeta local I (T_{27}) x Pilangatta local II (T_{43}). The intracluster distance was the highest for the cluster V. Number of flowers per plant contributed maximum to the total divergence followed by number of leaves per plant. Clustering pattern was not related to the geographical similarities but was related to the morphological similarities. The results suggests that selection of parents from these divergent clusters will be effective in future hybridisation programme.

In Experiment II, 40 genotypes of ivygourd from different agroclimatic regions were raised in randomised block design with 3 replications. In addition to the observations made in Experiment I, the following observations were also made viz., number of fruits per plant, fruit yield per plant, single fruit weight, single fruit size, number of seeds per fruit, protein content in fruits, vitamin A in fruits and vitamin C in fruits. The data collected were subjected to analysis of variance and the genetic parameters like variability, heritability, genetic advance, correlation coefficients and path coefficients were estimated. A selection index was also formulated to identify superior genotypes.

Analysis of variance revealed significant differences among the genotypes for all the sixteen characters studied. Maximum fruits were obtained from Alappuzha local (T_{36}) and the highest mean fruit weight was for Nangikadapuram local (T_{21}). A wide range of variation was noticed for these characters. Fruit yield was maximum for Nangikadapuram local (T_{21}).

The classification of genotypes into poor, medium and better groups indicated normality of the data for almost all characters in the material under study.

Nangikadapuram local (T_{21}), Kanjangad local (T_{30}) and Alappuzha local (T_{36}) performed better for most of the characters, while Kalikadavu local (T_{32}), Thalapadi local (T_{28}) and Pilangatta local (T_8) were poor in most of the characters.

In this study high phenotypic coefficient of variation and genotypic coefficient of variation were observed for fruit yield per plant, number of flowers per plant and number of fruits per plant, which indicates high genetic variability and better scope for improvement of these characters through selection. Comparatively low coefficients of variation were recorded for number of days for first flower opening, number of leaves per plant and single fruit weight indicating low variability and thus limiting the scope for further improvement through selection. The difference between phenotypic coefficient of variation and genotypic coefficient of variation were least for fruit yield per plant, number of flowers per plant and number of fruits per plant indicating the negligible influence of environment over these characters.

High heritability estimates were recorded for all characters except number of branches per plant, which had moderate value. Heritability was maximum for vitamin A in fruits followed by number of flowers per plant, number of fruits per plant and fruit yield per plant.

High genetic advance was noted for fruit yield per plant, number of flowers per plant and number of fruits per plant while number of days for first flower opening and number of branches per plant recorded low genetic advance.

High heritability in conjunction with high genetic advance as percentage of mean were observed for fruit yield per plant, number of flowers per plant and number of fruits per plant suggests that these characters are under the control of additive gene action and selection may be effective. High values of heritability in association with low genetic advance for the character number of days to flower opening implied the role of non-additive gene action. The high heritability is being exhibited due to favourable influence of environment rather than genotype and selection for such trait may not be rewarding.

In general the genotypic correlation coefficients were higher than other corresponding phenotypic and environmental correlation coefficients. This revealed that the phenotypic expression of these correlations are reduced owing to the influence of the environment. Yield per plant exhibited positive association with all the characters except number of days for flowering, which had significant negative correlation with yield. Among the yield components number of fruits per plant showed high positive correlation with number of flowers per plant followed by vine length and number of branches per plant whereas it exhibited high negative correlation with number of days for first flowering. Such correlation reveal the possibility that in crop selection for strains with more number of fruits can be expected to result in strains with higher yield.

Path coefficient analysis revealed that number of fruits per plant and single fruit weight were the characters with high direct effect as well as indirect effect through other characters on fruit yield per plant. The genotypic correlation of these characters with yield was also high. So these characters might be considered as the main characters for selection. The characters selected for path analysis would explain the major portion of variation in yield as the residual effect obtained was very low.

Based on the above results, a selection index was formulated and Alappuzha local, Kanjangad local, Thirunelli local, Mancheswarm local and Nangikadapuram local were identified as the five top ranking genetically superior ivygourd genotypes.

To sum up, this pioneering study indicates that being strictly a cross pollinated crop with possibility for vegetative propagation, methods of breeding which can be successfully followed are individual plant selection, mass selection to improve varieties, pedigree method and heterosis breeding and vegetative propagation of the heterotic combinations. Considerable variability of the crop has been observed in Karnataka, Andhra Pradesh, Tamil Nadu and northern parts of Kerala. There is considerable scope for survey, collection and maintenance of the germplasm. The study highlights the feasibility of producing commercially viable indigenous selections and hybrids which are early, producing more number of bold and tender fruits with good storability and resistance to pest and diseases.

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* Original not seen

GENETIC ANALYSIS
IN
IVYGOURD
(Coccinia grandis (L.) *Voigt.)*

SIBY VARGHESE

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ABSTRACT

The present investigation entitled "Genetic Analysis in Ivygourd (*Coccinia grandis (L.) Voigt.*) was conducted at the Department of Plant Breeding and Genetics, College of Agriculture, Vellayani during 1999-2001. Objective of the study was to estimate the genetic basis of different characters, genetic divergence in the germplasm and to formulate a selection index for identifying superior types. The material for the experiment was 90 different local cultivars collected from different agroclimatic regions. The data for the investigation were collected from two field experiments, each laid out in Randomised Block Design with three replications.

In Experiment I a collection of 50 genotypes of ivygourd was grouped into 11 clusters using Mahalanobis D^2 statistic and based on eight morphological characters. Five genotypes Kuriyabandar local I, Kuriyabandar local III, Pilangatta local II & III and Kudlu local I, could not be grouped with others and so are kept as independent clusters. The cluster C IX was found to have maximum intercluster distance with seven of the eleven clusters formed. This was followed by C II which showed maximum divergence with four out of the eleven clusters. The results suggest that selection of parents from these divergent clusters will be effective in future hybridisation programme. The three superior crosses identified were Balthangadi local I x Pilangatta local II, Bandargram local I x Pilangatta local II and Seethambeta local I x Pilangatta local II. Number of flowers per plant and number of leaves per plant were found to be the two characters that contributed

maximum for the divergence of the genotypes. So both at phenotypic and cluster levels, these two characters can be considered as potential contributors of differentiation in Ivygourd.

In Experiment II the data collected from 40 genotypes of ivygourd were subjected to analysis of variance and the genetic parameters like variability, heritability, genetic advance, correlation coefficients and path coefficients were estimated. Based on the above observation, a selection index was also formulated. Significant genotypic differences were observed among the 40 genotypes for all of the sixteen characters studied. High genetic variability was expressed by the characters fruit yield per plant, number of fruits per plant and number of flowers per plant. High heritability along with a good genetic advance was found for all the characters studied, except for number of days for first flower opening which exhibited high heritability and low genetic advance. These results indicate that the selection of plants which are phenotypically superior with respect to fifteen of the characters studied will certainly result in a significant improvement in the next generation.

The genotypic correlation coefficients were higher than the corresponding phenotypic and environmental correlation coefficients revealing the fact that phenotypic expression of these correlations are reduced due to the influence of the environment. Yield per plant exhibited positive association with all the characters except number of days for flowering, which had significant negative correlation with yield. Number of fruits per plant and single fruit weight were the characters with high direct and indirect effects. Based on the above results, a selection index was formulated and local cultivars of Alappuzha, Kanjangad, Thirunelli, Mancheswaram and Nangikadapuram were identified as the five top ranking genetically superior ivygourd genotypes.

To sum up, the results of the present study indicates that being strictly a cross pollinated crop with possibility for vegetative propagation, methods of breeding which can be successfully followed are individual plant selection, mass selection to improve varieties, pedigree method and heterosis breeding and vegetative propagation of the heterotic combinations. Considerable variability of the crop has been observed in Karnataka, Andhra Pradesh, Tamil Nadu and northern parts of Kerala. There is considerable scope for survey, collection and maintenance of germplasm. The study highlights the feasibility of producing commercially viable indigenous selections and hybrids which are early, producing more number of bold and tender fruits with good storability and resistance to pest and diseases.