

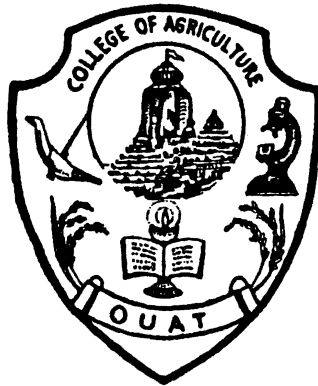
**GENETIC VARIABILITY IN**  
*Melothria heterophylla* (Lour.) Cogn.

A THESIS SUBMITTED TO  
THE ORISSA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY, BHUBANESWAR  
IN PARTIAL FULFILMENT OF THE REQUIREMENTS

**FOR THE DEGREE OF**  
**MASTER OF SCIENCE IN AGRICULTURE**  
**(HORTICULTURE)**

**BY**

*Biswaranjan Sethy*



Department of Horticulture  
**COLLEGE OF AGRICULTURE**  
*Orissa University of Agriculture & Technology*  
**BHUBANESWAR**  
**1996**

THESIS ADVISOR

Prof. T. MAHARANA

*Dedicated to*  
*My*  
**Beloved Parents**

**Prof. T. Maharana**, M.Sc(Ag) Ph.D.  
Professor in Horticulture-cum-Associate Director of Research(Seeds),  
O.U.A.T.,Bhubaneswar.

Bhubaneswar  
Dated, the 16<sup>th</sup> February, 1998.

## CERTIFICATE-I

This is to certify that the thesis entitled "**GENETIC VARIABILITY IN *Melothria heterophylla* (Lour) Cogn.**" submitted in partial fulfillment of the requirements for the award of the degree of **MASTER OF SCIENCE IN AGRICULTURE (HORTICULTURE)** of the Orissa University of Agriculture and Technology, Bhubaneswar is a faithful record of bonafide research work carried out by *Biswaranjan Sethy* under my supervision and guidance and no part of the thesis has been submitted for any other degree or diploma or published in any other form.

It is further certified that the help and assistance received during the course of investigation have been duly acknowledged by him.

forwarded to Dean,  
College of Agriculture.

*XP/My*  
16/2/98


*T. Maharana*  
16/2/98  
(Prof. T. Maharana)

Department of Horticulture  
College of Agriculture, O.U.A.T.,  
Bhubaneswar

## CERTIFICATE-II

This is to certify that the thesis entitled "**Genetic variability in *Melothria heterophylla*(Lour) Cogn.**" submitted by *Biswaranjan Sethy* to the Orissa University of Agriculture and Technology, Bhubaneswar in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN AGRICULTURE** in the subject **HORTICULTURE** has been approved by the student's Advisory committee after an oral examination on the same in collaboration with the external examiner.



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CHAIRMAN



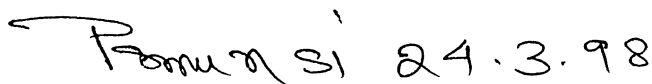
**Prof. T. Maharana,**  
Professor in Horticulture-cum-Associate Director  
of Research(Seeds), O.U.A.T., Bhubaneswar

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**Prof. D. P. Ray**  
Head, Department of Horticulture,  
College of Agriculture, O.U.A.T.,  
Bhubaneswar.



**Dr. B.K. Mahapatra**  
Reader,  
Department of Plant Breeding and Genetics,  
College of Agriculture, O.U.A.T.,  
Bhubaneswar



EXTERNAL EXAMINER

## ACKNOWLEDGEMENT

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Last but not the least I surrender my prostrations, regards and myself before **LORD JAGANNATH** to grant me his eternal benedictions and belongingness which guides and enlightens me to every bit and fragments of time.

Bhubaneswar,  
Dated, the 26<sup>th</sup> February, 1998

Biswanjan Sethy  
(Biswa Ranjan Sethy)  
Adm no-1244/98

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## ABSTRACT

01. Title of thesis : “Genetic variability in *Melothria heterophylla* (Lour.) Cogn.”
02. Author : Biswaranjan Sethy
03. Major Advisor & Designation : Prof. (Dr.) T. Maharana, Professor in Horticulture-cum-A.D.R. (Seeds), OUAT, Bhubaneswar.
04. Degree for which this thesis is submitted : M.Sc. (Ag), Horticulture.
05. Year of submission of thesis : 1996
06. Salient results :

*Melothria heterophylla* (Lour) Cogn. is a dioecious cucurbits and newly domesticated in some parts of our country. So scientific informations on the genetics and plant breeding of the crop are not available in any documented manuscript.

Therefore, in an attempt to generate informations on the crop, 15 genotypes collected from the genetic stock and evaluated to a replicated yield trial at the Horticultural Research station, O.U.A.T., Bhubaneswar during 1996-97. the major studies of this research were:

- \* the magnitude of genetic variance in the genotypes.
- \* estimation of simple genetic parameters like variability, heritability and genetic advance.
- \* the amount and nature of association among different characters through correlation studies.
- \* path coefficient analysis to assess the direct and indirect effect of crop on yield.
- \* measurement of genetic divergence among the genotypes based on their genetic distance.

*Melothria heterophylla* (Lour) Cogn. is a high priced vegetables and as the name *heterophylla* indicates that there is a large heterogeneous characters present on it. The variability studies indicated moderate to high level of variation due to genotype (GCV = 6.77 - 62.76) and phenotype (PCV = 838-64.00). Very high heritability (>90%) was exhibited in all characters except internodal length and girth of edible fruit because of environment favouring character expression. High GCV and heritability estimates associated with greater GA was observed for leaf lobe number, leaf area & yield per plant indicated that these three characters had additive gene effect and therefore more reliable for effective selection.

Yield was found to be positively & significantly correlated with weight of edible fruit, days taken for edible maturity, number of seeds per fruit, length of ovary before anthesis, length of edible fruit and seed weight of edible fruit indicated that any increase in latter five characters should bring about an enhancement in the yield. Path analysis revealed that maximum weightage should be given primarily to weight of edible fruit followed by number of fruits per plant, internodal length, seed weight of edible fruit, length of edible fruit, leaf area and leaf lobe number while formulating selection indices for improvement of yield of *Melothria heterophylla* (Lour) Cogn. The D<sup>2</sup> analysis indicated that, there were one monogenotypic cluster i.e., BMH-31 and four monogenotypic subclusters i.e., BMH-16, BMH-24, BMH-26. The study indicated that a reciprocal recurrent selection by using best genotypes from each cluster and subcluster would be high value from the yield improvement point of view in the *Melothria heterophylla* (Lour.) Cogn.

CHAPTER - I

*Introduction*

# INTRODUCTION

Family cucurbitaceae consists of 117 genera and 825 species. Out of them nearly 20 species belonging to 9 genera are mainly cultivated for vegetable purposes. They are good source of carbohydrates. Few cucurbits are having low calorific value for which they are use as food in special health conditions. The seeds of several cucurbits are rich in oil and protein which make a nutritious confection when roasted & salted. The important cucurbit vegetables are pumpkin, ash gourd, bitter gourd, watermelon, musk melon, bottle gourd, snake gourd etc.. Few cucurbits are relatively grown in smaller quantities and consumed locally. They are called as minor cucurbits. The minor cucurbits include spine gourd, pointed gourd, ivy gourd chow-chow, meetha karela etc.. Many of the minor cucurbits are associated with special genetical characters which prevents them to be domesticated and grown in wide scale. The important production constraints in minor cucurbits are: (i) high dioecism (ii) wide range of variability (iii) highly susceptible to pests & diseases.

*Melothria heterophylla* (Lour) Cogn. is one of the important minor cucurbit. The word *Melothria* derived from Greek word i.e., melon means apple. Under the genus *Melothria* there are about 70 species, most of the member of the species are distributed in the tropics of the world. About 12 species occur in India. *Melothria heterophylla* (Lour) Cogn. is grown in shrubby areas as a slender herbaceous vine, it climbs on small trees or trails on the ground. The above vine dies during winter but the plant is survived through a fasciculated root system. The flowers are small, yellow or white in colour; fruits are small & attractive. The tender fruits are eaten as vegetable, ripe fruit mostly develop a rich scarlet colour & very much sweet & attractive to birds.

*Melothria heterophylla* (Lour) Cogn. has not yet been domesticated in our state. The fruits are mainly collected from jungles. Of late some attempts has been made to domesticate the crop. No formal data on method of cultivation and botany of the crop is available. High degree of variability is noticed as regard to the leaf lobe number, leaf size, fruit shape, colour, size etc.. Even in the some plant the leaf shape changes with the growth of the vine. Therefore the present investigation entitled " Genetic variability in *Melothria heterophylla* (Lour) Cogn." has been under taken to study the followings.

- 1) The magnitude of genetic variance in the collection.
- 2) The nature and extent of variability and heritability of characters and their expected genetic gain by selection.
- 3) The amount and nature of association among different characters through correlation analysis.
- 4) The direct and indirect association among yield components through path coefficient analysis.
- 5) The genotypes for components of productivity and assess genetic divergence among them basing on their genetic distance.

CHAPTER - II

Review of Literature

# REVIEW OF LITERATURE

Among the minor cucurbits *Momordica dioica*, *Momordica cochinchinensis*, *Melothria heterophylla* are rare table delicacy. They are grown as wild plants in several parts of India. These crops are not popular as profiteering crops under field crops due to dioecious nature & pest disease problems. Very little achievement has been made through research work on these crops. The genus *Melothria* comprises of 70 species, out of which 12 species have been reported in India. The present research project entitled " Genetic variability in *Melothria heterophylla*"(Lour) Cogn. has been under taken for developing a crop improvement programme. Since no literature is available particularly on *Melothria*, attempt has been made in this chapter to document few of comparative literatures achieved in other cucurbits; mainly dioecious cucurbits.

## **Taxonomy**

Muller and Pax (1894) have divided the cucurbitaceae into five sub families: 1. Fevilleae; 2. Melothriaceae; 3. Cucurbitaceae; 4. Sicyoideae; and 5. Cyclanthereae. The important cultivated genera are found only in the subfamilies Cucurbitaceae and Sicyoideae. A general outline is given herewith for different plant parts of cucurbits.

## **Morphology**

**Roots :** The root system of all the economic cucurbits is extensive but shallow. Upon germination of seed, the plants soon develop a strong tap root which according to Weaver & Burner (1927), may penetrate the soil at a rate of 1 inch per day to a depth of 3 or 4 ft. in *Cucumis*, and upto 6ft in *Cucurbita*. Horizontal laterals develop rapidly & spread widely in the soil.

**Stems :** All cucurbits are alike in their genera in stem morphology. From three to eight lateral branches arise from as many nodes near the base of the main axis. The main axis is a sympodium. The primary branches often nearly equal the central stem in their development.

**Leaves :** The leaves are simple and mostly three to five-lobed. There is much variation, however, among species and cultivars, in the shape, size, and depth of the lobes. Yasuda (1903) found that in some cultivars there are areas on the under sides of the leaves where the epidermal cells are two or three layer thick. Such spots have an etiolated appearance.

**Tendrils :** Tendrils are borne in the axils of the leaves and are characteristic of most cucurbits. They may be branched or simple.

**Flowers :** With regard to sex expression, the cucurbitaceae usually fall into two groups- monoecious, andromonoecious and dioecious . The flowers of different genera and species vary considerably in their size and colour, but mostly similar in general morphology. Flowers are borne in the axils of the leaves. The ratio of pistillate to staminate flowers varies among species and cultivars, but the number of staminate flowers produced always exceeds that of the pistillate ones (Whitaker, 1931).

**Fruits :** The fruits of cultivated cucurbits vary greatly in size, shape and colour. The fruit is indehiscent, with fleshy floral tube adnate to the pericarp. It is classified as an inferior berry, or pepo, by L.H. Bailey (1949). In the young fruit rapidly dividing cork cells are found below the epicarps, and as the fruit matures, this growth breaks through to form the so called 'net'. Barber (1909) finds that this tissue consists of small, thin walled cells, radially arranged, which together with the ruptured epicarp, some what resemble to lenticels.

**Seeds :** The seeds of the cultivated cucurbitaceae vary in size, shape and colour, in the presence or absence of a margin, and the type of scar formed at the hilum. In general, each seed has a firm testa of several layers, a thin collapsed perisperm and endosperm, and a large embryo. The embryo consists of two large, flat, leaf like cotyledons and a small radicle. The seeds may be flat or round. *Sechium edule* is having only one seed where as all other cucurbits are multiseeded.

**Dormancy of seed and tubes :** Sahoo and Maharana (1984) found that the seeds remain dormant for 71 days and 26 days in *Momordica dioica* and *M. cochinchinensis* respectively. In tubers nearly 74 days dormancy was observed in *Momordica diocia* and 28 days in *M.Cochinchinensis*.

The genera *Melothria* is under subfamily Melothrieae. The important characters of different species under *Melothria* are given below.

Table.- 1 Characters & uses of different species of genus *Melothria*.

Name of the Species	Plant characters	Uses
<i>M. heterophylla</i> (Lour) Cogn. Syn. <i>Zehneria umbellata</i> Hindi - Tarali Oriya- Karikia, Matka, Makirla Chakravarty (1959) Kirt & Basu (1935)	Scandent herb, tuberous root, leaves polymorphous, ovate, sub-orbicular, oblong or narrowly lanceolate, undivided or variously lobed, remotely denticulate; flowers small, yellows; male flowers various, subumbellate, umbellate, racemes or densely or laxly fascicled, female flowers solitary; fruits oblong, brown, with many subspherical, smooth seeds.	The roots, leaves & fruits are eaten. Root is considered stimulant, invigorating and purgative; it is used for gonorrhoea and dysuria. In Konkan the juice of root, mixed with cumin and sugar is given in cold milk as a remedy for spermatorrhoea. Juice of leaves is applied to the parts inflamed by the application of the marking nut juice. In Indo-china the seeds are used as purgative. (Haines, 1921; Nandakami, 1954; Burkill, 1909)
<i>M. maderaspatana</i> (Linn) Cogn Syn. <i>Mukia scabrella</i> Hindi-Agumuki, Bilari	Prostrate or climbing annual herb. Leaves ovate or sub-deltoid, entire or 3-5 lobed, minutely denticulate; flowers small, yellow; male flowers fascicled, female flowers solitary or subfasciculate; fruits globose, brownish yellow; seeds ovoid.	The tender shoots and bitter leaves are used as a gentle aperient & prescribed in vertigo & biliousness. Roots when masticated relieves tooth ache; Due to its expectorant properties the plant is used in compound preparations for cough but action is slow. Seed is considered sudorific.
<i>M. Indica</i> (Lour)	Scandent or spreading herb, found in Tehri Garhwal, Sikkim, Assam & Naga hills.	The juice of the leaves is applied in sores of thrush, and is used in the treatment of eye diseases. Fruit possesses purgative properties.
<i>M.Perpusilla</i> (Blume) Syn, <i>Zehneria hookcriana</i> Bombay- Varali M.P.- Bankundri	Climbing herb found in the upper Gangetic plain from Nepal to Assam.	The root is used with milk in fever & diarrhoea.

Name of the Species	Plant characters	Uses
<i>M. scabra</i> (Naudin)	Stems more or less hairy: Leaves rigid, Ovate-oblong or somewhat triangular-hastate, acute or shot acuminate, scabrous: tendrils filiform, short: flowers small, the masculine racemes 5-7 flowered and equaling the petiole; anthers roundish with a wide connective. Fruit ovoid-oblong, obtuse, three celled, rather large with parallel stripes of white & green.	
<i>M. pendula</i> (Linn)	Creeping or scandent, much branched root-perennial, the stem glabrous and shining. Leaves sub-orbicular-cordate, acute or obtuse, hirsute becoming scabrous, often deeply 5-lobed, the lobe obtuse: Male racemes 3-7 flowered, usually shorter than the petioles, corolla yellow, the segments obovate: Fruit ellipsoid, to 1/2 inch long, the seed obovate and whitish.	
<i>M. japonica</i> (Maxim)	Leaves ovate-triangular, emarginate at base, scabrous above, nearly smooth beneath, entire or shallowly 3-lobed: Male flowers solitary; anthers sub-orbicular, not appendaged at apex. Fruit ovoid-sub-globose, the seeds usually marginless.	
<i>M. punctata</i> (Cogn)	Stem glabrous at maturity, angled: Leaves membranous, cordate, angled on slightly 3-5lobed, white spotted and somewhat scabrous above. Fruit brown, lightly pitted, seeds small about 2 lines long, strongly compressed. It blooms in cluster, Flowers small, white and star shaped with a strong musk fragrance.	

### **Variability and heritability in dioecious cucurbits :**

Singh *et al.* (1985) studied variability in pointed gourd cultivars and found narrow range of variability in the characters like node bearing first flower, number of days to first flowering, internodal elongation, pulp content of fruit, skin thickness of fruit, and leaf area, where as fruit length, seed size, seed weight, seed volume, seed weight, and fruit yield show higher coefficient of genetic variability while days to first flower and fruit weight showed low coefficient of variation indicating lower genetic variability. The genetic advance as percentage of mean was highest for seed number per fruit, fruit length, diameter of fruit, yield per plant expressed high heritability.

Singh and Krishnaprasad (1989) found high variability among 25 cultivars of pointed gourd for characters like number of nodes, shoots and fruits, fruit length and volume and yield per plant. He also found maximum amount of genetic variation in number of shoots, yield per plant, fruit length and fruit weight.

Prasad and Singh (1990) conducted a study on morphological and agronomical components of pointed gourd. They observed higher yield was correlated with late flowering as demonstrated in CHESS-12. The fruit weight (34.6g) and the seed number (19.9) were the highest in CHESS-14. The results indicated that the number of seeds per fruit had direct correlation with fruit weight.

### **Variability & heritability in other cucurbits:**

Solanki and Seth (1980), observed considerable phenotypic variability existing among 24 varieties for height, number of leaves per plant, number of male flowers per plant, number of days to maturity and number of female flowers per plant in cucumber. They found high heritability and high genetic advance for the above characters and fruit yield and internode length which were found to be governed by additive genes.

Indiresh (1982) assessed 24 lines of bitter gourd and reported high genetic coefficient of variation for fruit fresh weight, yield per plant, fruit cavity length, leaf area and fruit length. High heritability was found for all characters except yield per plant and days for fruit development.

Rana (1982) reported significant difference among ten characters in 19 lines of pumpkin grown in two experiments. High estimates of heritability and genetic advance for vine length and percentage fruit set were also noticed by him.

Lippert *et al.* (1982) found that heritability estimates were low for maturity and yield traits (5-13%) and moderate (53-75%) for fruit appearance and quality traits in musk melon.

Vashistha *et al.* (1983) studied yield and 8 yield related characters in 14 varieties of watermelon and concluded that heritability estimates were high for all characters except yield per plant.

Prasad *et al.* (1984) analysed data regarding yield per plant and 16 yield related traits by studying 40 Indian varieties of sponge gourd they found heritability estimates of 100% for yield per plant and other four traits. High value of both heritability and genetic advance were reported for 5 traits including fruit length and fruit diameter.

Hassan *et al.* (1984) studied genetic behaviour of four fruit characters, 100-seed weight and stem length in Indian squash (*Cucurbita ssp.*). According to them broad sense and narrow sense heritability values for fruit length were 80% and 51% respectively. Further estimates of heritability in broad sense for fruit weight was high and affected by environment.

In a study of 45 genotypes of musk melon, Swamy *et al.* (1985) reported high heritability values for presence or absence of sutures and netting, fruit shape, flesh thickness, average weight per fruit, total yield per plant and titrable acidity.

Doijode (1986) studied genotypic and phenotypic coefficient of variation and heritability for 7 traits in pumpkin related to fruit yield. Heritability was highest for  $\beta$ -carotene (98.6%), seed size index (89.5%) and fruit weight (82.9%) and genetic advance was highest for  $\beta$ -carotene.

Strefeler (1986) found heritability and genetic variances of three yield and five quality traits in 3 fresh market cucumber populations in which heritabilities based on full-sib family selection for fruit yield ranged from 0.03 to 0.25.

Prasad *et al.* (1988) evaluated 9 germplasm lines of watermelon for 14 characters and reported high genotypic and phenotypic coefficient of variation for fruits per plant, average fruit weight, seeds per fruit, 100 seed weight, and fruit yield per plant. These characters also showed high heritability and genetic advance values.

Singh *et al.* (1989) estimated genetic variance and heritability for 5 yield and growth period related characters in six *Cucumis melo* cultivars and reported WMR-29 and Punjab Sunehri as best parents on the basis of their mean performance.

Krishnaprasad *et al.* (1989) studied eleven varieties of ridge gourd & found high phenotypic and genotypic coefficient of variation in yield per plot, yield in quintals per hectare and number of fruits indicated the existence of variability for selection based on these characters. High heritability and high genetic advance in yield in quintals per hectare, yield per plot and number of fruits.

Rajnarayan *et al.* (1996) studied on 25 diverse plants of bottle gourd & found that high value of GCV and heritability estimates associated with greater genetic advance for number of primary branches per plant and yield per plant.

## **CHARACTER ASSOCIATION**

In crop plants the most important economic characters is yield, which is complex one and is dependent on a number of directly and indirectly associated components. Selection for one character would result in progress for all positively correlated characters. This relation suggests the advantage of a scheme for more than one characters at the same time (Baha Eldin *et al.*, 1968). If negative correlation exists between components of yield, then selection is to be done for intermediate combinations for improvement of yield. According to Randhwa *et al.* (1975), if a low heritable complex characters exhibits high correlation with other simply inherited characters, then it will be a great help for selection.

### **Character association in dioecious cucurbits :**

Singh and Krishnaprasad (1989) studied 25 cultivars of pointed gourd. They found that significant positive correlations exist between yield per plant and number of fruits, fruit volume and fruit weight and significant negative correlation in fruit width and number of nodes. However, high positive correlations though nonsignificant, were also found between number of shoots and number of nodes, number of fruits and number of shoots and between fruit length and number of fruits.

### **Characters association with other cucurbits**

While studying nine characters from 7 cultivars of watermelon Sidhu & Brar (1981) found that yield per plant was significantly correlated with 100 seed weight and fruit weight. TSS (%) and number of seeds per kg of flesh showed negative correlations with yield.

In watermelon Didenko *et al.* (1981) analysed 2256 pairs of characters in 180 varieties and reported that refractometer index was closely correlated with fruit flavour, juiciness and flesh colour. Ovary shape at flowering was correlated with fruit shape. Further main stem length, internode length and stem thickness were found to be correlated with plant vigour.

In pumpkin, Rana (1982) reported highly significant positive association of yield per plant with number of flowers per plant, fruit number, fruit weight and flesh thickness. He further reported that, correlations between most of the yield components were positive and significant.

Evaluation of yield per plant and 9 yield related characters in 19 genotypes of pumpkin was done by Rana *et al.* (1985). They found significant and positive correlation of yield per plant with number of female flower, number of fruits per plant, percent of fruit set, fruit weight and flesh thickness.

In muskmelon, Swamy (1986) revealed positive correlation of yield with number of fruits, average fruit weight, number of nodes in main stem, stem length, internode length, number of primary branches, fruit shape index and negative correlation with total soluble solids, ascorbic acid and dry matter content.

Prasad *et al.* (1988) evaluated 9 germplasm of watermelon lines and found correlation of fruit yield with vine length ( $r=0.47$ ) branches per plant (0.75), fruit weight (0.88), fruit length (0.63) and girth (0.61).

In watermelon, Zhang and Wang (1989) studied 21 lines and their 18 F<sub>1</sub> hybrids and reported a significant positive correlation between mid parental value and F<sub>1</sub> hybrids for fruit yield per plant, fruit number per plant, fruit weight, soluble solids content and resistance.

Ma Dehua *et al.* (1995) studied the phenotypic correlation on 16 characters in 16 F<sub>1</sub> cucumber hybrids & their 8 parents. They found total yield had a significant positive correlation with total fruit number ( $r=0.84$  or 0.83), fruit growth rate ( $r=0.66$  or 0.67) and average fruit weight ( $r=0.42$  or 0.41) while it was negatively correlated with Fusarium wilt incidence ( $r=-0.33$ ). Stem diameter & plant height also had an effect on total yield.

Rajnarayan *et al.* (1996) studied the correlation studied on 25 cultivars of bottle gourd & the study revealed that fruit yield per plant can be successfully improved by making selection on greater fruit number, higher fruit weight, greater number of primary branches and genotypes with lesser number of days to anthesis of first male flowers.

## **PATH ANALYSIS**

According to Wright (1921), path coefficient analysis provides a better knowledge of direct and indirect causes of associations and it permits a critical examination of the specific forces acting to produce a given correlation and measures the relative importance of each casual factor.

### **Path analysis in cucurbits :**

Gopalkrishnana *et al.* (1980) studied 25 quantitative characters in 18 genetically distinct types of pumpkin and reported greatest direct effects of main stem length and average fruit weight on yield.

Sidhu & Brar (1981) in a study of path coefficient analysis in watermelon indicated that number of nodes to first female flower and flesh weight had high direct as well as indirect effects on yield.

Rana (1982) conducted path coefficient analysis on 19 lines of pumpkin grown in two environments and noticed that the magnitude of direct effects of the characters studied on yield depended on environment.

In watermelon, Singh & Singh (1988) reported highest direct effects of number of fruits per vine and total soluble solids on yield. From a correlation study they concluded that the characters like number of days and node number for the appearance of the first female flower could be recommended to improve earliness.

Path coefficient analysis of yield attributes in cucumber comprising 75 diverse genotypes was studied by Abusalecha and Dutta (1988). The analysis revealed that fruits per vine and fruit length had the greatest direct effects on yield.

While studying path coefficient analysis in 21 lines of watermelon and their F<sub>1</sub> hybrids, Zhang and Wang (1989) reported that fruit weight had a direct effect on fruit yield per plant. Further apart from direct effects indirect effects on shoot thickness and fruit yield per plant mainly via fruit weight apart were also observed by them.

Raj Narayan studied the path analysis on bottle gourd & the analysis revealed that maximum weightage should be given primarily to days to the first harvest followed by average weight of edible fruit, number of fruits per plant and days to anthesis of first female flower while selecting indices for improvement of yield in bottle gourd.

## **GENETIC DIVERGENCE**

Selection of genetically divergent varieties is important in the exploitation of heterosis and in the development of transgressive segregants for an efficient breeding programme. The information regarding the nature and magnitude of genetic distance among the genotypes will help the breeder in choosing the suitable diverse combinations.

### **Genetic divergence in cucurbits**

Sidhu and Brar (1985) studied genetic divergence of watermelon on the basis of the Mahalanobis  $D^2$  statistics and Tocher's grouping. They grouped the 28 populations into 7 clusters, one of which had a single entry. Cluster I had 12 entries and they were from almost every parent indicating that the clustering pattern of the hybrids was not influenced by parentage. No obvious consistency occurred between parental divergence. Average fruit weight and fruit number per plant contributing most towards divergence was also reported by them.

Parhi, *et al.* (1993) Genetic divergence using Mahalanobis  $D^2$  statistics was studied on 14 quantitative characters including yield per plant in a collection of 13 genotypes of bitter gourd. The genotypes differed significantly for all the characters studied and were grouped into six clusters based on the similarities of  $D^2$  values. Considerable diversity within and between clusters were noted and it was observed that the characters like 100 seed weight, number of seeds per fruit and yield per plant contributed maximum to divergence. Hence, selection of divergent parents based on these characters may be useful for heterosis breeding in bitter gourd.

CHAPTER - III

Materials and Methods

## MATERIALS AND METHODS

The present investigation entitled “Genetic variability in *Melothria heterophylla* (Lour.) Cogn.” was carried out in the Department of Horticulture, OUAT in a adhoc scheme “Improvement of minor cucurbits” sanctioned by ICAR. The materials and methods employed in conducting this investigation are described briefly.

### Meteorological information

Bhubaneswar comes under humid tropical climate. It is located at 20°-15' North latitude and 85°-82' East longitude and at an altitude of 25.5. meters above the mean sea level. Further, it is located 62 kms west of Bay of Bengal in the state of Orissa. The mean annual precipitation is 1582.8mm of which 1515.3 mm is received from February to November. The average maximum temperature ranges from 34.1°C to 36.1°C during the month of April and May while average minimum temperature varies from 17.1°C to 22.1°C during February and March. The meteorological data obtained from the University observatory, Bhubaneswar during the period of experimentation are presented in Table-1.

**Table-2 : Meteorological information relating to research station from February 97 to November 1997.**

Month	Temperature (°C)			Relative humidity (%)			Rainfall (mm)	No. of rainy days	Sunshine hours
	Max.	Min.	Mean	F.N.	A.N.	Mean			
Feb. 97	31.1	17.1	24.1	92	39	65.5	8.0	2	9.2
Mar. 97	34.7	22.1	28.4	97	47	72	54.6	4	7.6
Apr. 97	34.1	21.9	28.0	91	59	75	135.6	11	8.3
May. 97	36.7	25.8	31.2	88	56	72	16.3	2	7.5
June 97	36.1	25.9	31.0	89	60	74.5	184.0	13	5.3
July 97	33.3	25.6	29.45	92	73	82.5	191.9	16	3.0
Aug. 97	32.0	24.8	28.4	94	80	87.0	534.7	21	4.4
Sept.97	32.3	24.6	28.45	95	79	87.0	348.6	17	5.0
Oct. 97	32.9	22.4	27.65	94	61	77.5	32.3	4	8.2
Nov. 97	32.1	20.9	26.5	94	56	75	9.4	1	7.8

## **Soil and Composition**

Experiments were conducted in Horticulture Reserch Station. Soil samples were collected at random from garden and the mechanical and chemical analysis of the composite samples were conducted and results are presented below.

The soil samples containing coarse sand 44.24%, fine sand 27.05%, silt 11.85%, Clay 16.86%. The total N<sub>2</sub> percentage of soil sample was 0.075, available P was 0.00125, available K was 0.00358, organic carbon 0.6945, C/N ratio 10.4 and pH of soil sample was 5.2.

## **Source of planting materials, selection, multiplication, planting, care of planting materials and experimental layout**

During the year 1994-96 tubers and seeds of *Melothria heterophylla* (Lour.)Cogn. were collected from undivided Puri, Cuttack and Ganjam district. Majority of collections were from Chandaka forest and from a private collection of Ballipada near Berhampur and maintained. Preliminary screening for female plants was made on the basis of duration of female phase, number of female flowers produced per day at peak stage, fruit size, weight of individual fruits and number of fruits produced per plant. The male plants were screened on the basis of duration of male phase, number of flowers produced per day at peak stage and pollen viability. The selected plants were multiplied sufficiently through stem cuttings and rooted stem cuttings were planted during 1996-97 in the Horticultural Research Station, Bhubaneswar in replicated manner. In each treatment 4 plants were plants at a distance of 1 mt x 1 mt. In each pit of 30 cm x 30cm x30cm size three cuttings were planted but one healthy plant was maintained after proper establishment. In between replication and the border cuttings of male plants of the selected lines were planted. In total 180 plants of 15 female lines were planted in 15 treatments and replicated thrice during 1996-97. Observations were recorded for the present study during Kharif 1997 and analysed data through randomized block design.

## **Observational technique and characters studied**

Data on various biometrical observations were recorded from all the four plants in each treatment. The average of four plants per replication for each character studied was subjected to statistical analysis. All the characters were studied at proper time.

The observations were recorded on the following growth yield and yield attributing characters for variability study. Some observations were also recorded on the qualitative parameters of the fruit and also documented.

### **A. Leaf characters**

**(a) Leaf length and leaf width :** Average of maximum length and width of the 7th and 8th leaf from the tip of the main branch at two months stage were measured in centimeters to indicate the dimension of the leaves. **(b) Actual leaf area:** At two months of growth, 7th and 8th leaf from the tip of the main branch were taken and their area was drawn on a graph paper. Actual leaf area was calculated on the basis of individual leaves and average was made. It was expressed in square centimeters. **(c) Leaf tenderness:** The 7th and 8th leaf from the tip of the main branch were taken & their tenderness were felt by rubbing the finger on the surface of leaf. **(d) Leaf colour:** 7th & 8th leaf from the tip of the main branch were collected and colour of leaf recorded visually. **(e) Leaf thickness:** The leaf of 7th & 8th from tip of main branch were taken for measuring leaf thickness by a micro dial gauge & expressed in centimeter. **(f) Internodal length:** The length of 7th and 8th internodes from the tip of main stem were measured and average was calculated and expressed in centimeters. **(g) Leaf lobe number:** The 7th and 8th leaf from the main branch were taken and lobe number calculated and average was made.

### **B. Flower characters**

**(a) Days taken for opening of flowers :** The period between initiation of tiny female flower bud to opening was recorded and expressed in days. **(b) Ovary length and girth before anthesis:** The 3rd & 4th flower bud were taken & the ovary length & width was measured, average was calculated & expressed in centimeters. **(c) Cluster of flower :** The number of flowers produced per node was counted and average was recorded.

### **C. Fruit characters**

**(a) Fruit length and girth :** The length & girth of three fruits at each harvest was measured at 2 stages one at edible stage & other in over mature stage. Then the mean values were recorded & expressed in centimeters. **(b) Fruit weight :** The fruits selected earlier for measuring fruit size were also utilised for recording the fruit weight at 3 stages i.e., edible maturity, over maturity & ripening stage at each harvest. The fruits were weighed and the mean weight was calculated in gm after the final harvest. **(c) Number of fruits per plant :** A record on number of fruits from each sample plant at each harvest was maintained and finally the total number of fruits per plant was determined. **(d) Fruit ridge number :** The fruits taken for measuring length and weight also used for calculating the number of ridge present on it & mean value was calculated. **(e) First fruiting height:** The distance from ground to first fruiting height was recorded and their mean value calculated & expressed in meters. **(f) Colour of fruit :** At edible maturity, fruit colour was recorded visually by seeing the outer surface of fruit. **(g) Keeping quality of fruit :** The edible mature and immature fruits are taken & kept under ordinary room temperature and the keeping quality were measured. Then their mean values were calculated & expressed in days. **(h) Fruit yield per plant :** Fresh weight of edible fruits per plant at different harvests were added up for calculating the sum total fruit yield per plant and expressed in kilograms. **(i) Day taken for edible maturity :** After fruit development the time taken for attaining edible maturity was calculated & their mean values were estimated & expressed in days. **(j) Number of seeds per fruit :** The seeds were separated from the pulp of twenty five fruits of each treatment and counted. The mean value was documented. **(k) Seed weight :** The seeds separated from fruits at edible maturity, over maturity and ripening stage were weighed & the mean values were calculated & expressed in grams.

### **D. Other plant characters**

**(a) Plant height :** The plant height in different treatments were calculated at 2nd week of September '97. The average values were recorded and expressed in meters. **(b) Number of main branches :** At the time of taking plant height, the main branches per plant also calculated and their mean values recorded. **(c) Girth of stem :** At the time of

recording plant height, girth of main stem at 30 cm height from ground level was recorded & the average was expressed in centimeters. **(d) Branching height :** In the second week of September '97 the distance from ground level to produce first branching was measured & the average of four plants expressed in centimeters.

### Statistical analysis

The data recorded were subjected to statistical analysis based on sample means of the various characters under observation.

**Analysis of Variance :** The analysis of variance was carried out separately for 14 characters following the procedures of randomised block design analysis (Panse and Sukhatme, 1954). Analysis of variance was done on the basis of the following model.

$$Y_{ij} = m + g_i + r_j + e_{ij}$$

Where,

$Y_{ij}$  = Phenotypic observation in the  $i^{\text{th}}$  genotype and  $j^{\text{th}}$  replication.

$m$  = General mean

$g_i$  = Effect of the  $i^{\text{th}}$  genotype

$r_j$  = Effect of the  $j^{\text{th}}$  replication.

$e_{ij}$  = Random error associated with  $i^{\text{th}}$  genotype and  $j^{\text{th}}$  replication.

### Form of the analysis of variance and expected mean square

<u>Source</u>	<u>df</u>	<u>M.S.</u>	<u>Expected mean sum of square</u>
Replication	(r-1)	$M_R$	$\sigma^2_e + g\sigma^2_r$
Genotype	(g-1)	$M_G$	$\sigma^2_e + r\sigma^2_g$
Error	(r-1)(g-1)	$M_E$	$\sigma^2_e$

### Mean, range, standard error and critical difference:

Mean values of each character was worked out by dividing the total with corresponding number of observations, while the lowest and highest values for each character were taken as the range.

The S.E. and C.D. were calculate by using the following formula:

$$\text{Standard error of difference (SED)} = \sqrt{2\text{EMS}/r}$$

$$\text{C.D.} = \sqrt{2\text{EMS}/r} \times t \text{ values at error degrees of freedom at 5\% levels of significance.}$$

Where,

r= Number of replication

EMS= Error means sum of square.

**Coefficient of variation :** From the structure of the analysis of variance.

$$\text{Error variance} = \sigma_e^2 + M_E$$

$$\text{Genotypic variance} = \sigma_g^2 = (M_G - M_E)/r$$

$$\text{Phenotypic variance} = \sigma_p^2 = M_G/r = \sigma_g^2 + \sigma_e^2/r$$

The genotypic coefficient of variation (GCV) and the phenotypic coefficient of variation (PCV) were calculated by the formula given by Burton (1952).

$$\text{GCV} = \frac{\text{Genotypic standard deviation}}{\text{Grand mean}} \times 100$$

$$\text{PCV} = \frac{\text{Phenotypic standard deviation}}{\text{Grand mean}} \times 100$$

### Heritability (Broad Sense) :

Degree of correspondence between phenotypic value and breeding value is measured by the heritability estimate. Heritability ( $h^2$ ) estimate was worked out by using the formula suggested by Lush (1949) and Burton and Devance (1953). This was expressed in percentage according to Weber and Moorty (1952).

$$h^2 \text{ (Broad Sense)} = \frac{\text{Genotypic variance}}{\text{Phenotypic variance}} \times 100$$

**Expected genetic advance :** Genetic advance was estimated as per the formula suggested by Johnson, Robinson and Comstock (1955).

$$GA = K.h^2 \sigma_p$$

Where,

K= Selection differential in standard units which is 2.06 for 5% selection intensity.

$h^2$  = heritability in broad sense

$\sigma_p$  = Phenotypic standard deviation

GA expressed as percentage of mean = (GA/mean) x 100

### Analysis of co-variance

The analysis of co-variance between all possible pairs of characters was done on plot mean value following the procedures of Randomised Block design analysis (Panse and Sukhatme, 1954).

### Form of co-variance and expected mean sum of products :

<u>Source</u>	<u>df</u>	<u>mp</u>	<u>Expected mean sum of products</u>
Replication	(r-1)	$M_{R(xy)}$	$\sigma_{e(xy)} + g\sigma_r(xy)$
Genotype	(g-1)	$M_{G(xy)}$	$\sigma_e(xy) + r\sigma_g(xy)$
Error	(r-1)x (g-1)	$M_{E(xy)}$	$\sigma_e(xy)$

$M_{R(xy)}$ ,  $M_{G(xy)}$  and  $M_{E(xy)}$  stand for mean sum of products between pairs of characters due to replication genotypes and error respectively. From the structure of analysis of co-variance the following estimates were computed.

$$\text{Error co-variance} = \sigma_{e(xy)} = M_{E(xy)}$$

$$\text{Genotypic covariance} = \sigma_{g(xy)} = [M_{G(xy)} - M_{E(xy)}]/r$$

$$\text{Phenotypic covariance} = \sigma_{p(xy)} = M_{G(xy)}/r = \sigma_{gxy} + [\sigma_{e(xy)}]/r$$

### **Estimation of Correlation coefficients :**

Simple correlation coefficients were computed at genotypic and phenotypic levels between pairs of characters adopting the following formula.

$$\text{Genotypic Correlation } (r_g) = \sigma_{g(xy)} / \{\sigma_{g(x)} \times \sigma_{g(y)}\}$$

$$\text{Phenotypic correlation } (r_p) = \sigma_{p(xy)} / (\sigma_{p(x)} \times \sigma_{p(y)})$$

Where,

$\sigma_{g(xy)}$  = Genotypic co-variance between the two traits x and y

$\sigma_{g(x)}$  and  $\sigma_{g(y)}$  stand for genotypic standard deviations for x and y respectively.

$\sigma_{p(x)}$  and  $\sigma_{p(y)}$  stand for phenotypic standard deviations for x and y respectively.

To test the significance of correlation coefficients at phenotypic level, the estimated values were compared with the table value (Fisher and Yates, 1967) at (n-2) degrees of freedom at the 5 percent and 1 percent levels of significance.

### **Path coefficient analysis**

The path coefficient analysis is a type of cause and effect relationship among the various correlated characters. Path coefficients were standardised partial regression coefficients which individually provide a measure of direct effect of the causal factors on the effect variable. These permit partitioning of the correlations between causal factor and the effect of variables into components of direct and indirect effects and thus, give a better picture of the associations of the causal factors with the effect variable.

In the present investigation, yield per plant was taken as the effect with other characters like days taken for edible maturity, leaf area, leaf lobe number, plant height, number of main branches, internodal length, length of ovary, seed weight of edible fruit, number of seeds per fruit, length of edible fruit, girth of edible fruit, weight of edible fruit, number of fruits per plant to yield as the casual factors. The path coefficients were obtained by solving the following simultaneous equations and path coefficients in a system of correlated causes (Wright, 1971, Dewey and Lu, 1959).

$$r_{1.14} = p_{1.14} + r_{1.2} p_{2.14} + r_{1.3} p_{3.14} + \dots + r_{1.13} p_{13.14}$$

$$r_{2.14} = r_{2.1} p_{1.14} + p_{2.14} + r_{2.4} p_{3.14} + \dots + r_{2.13} p_{13.14}$$

$$r_{13.14} = r_{13.1} p_{1.14} + r_{13.2} p_{2.14} + r_{13.3} p_{3.14} + \dots + p_{13.14}$$

Where,  $r_{ij}$  is the coefficient of correlation between  $i^{\text{th}}$  and  $j^{\text{th}}$  characters and  $p_{qi}$  is the path coefficient (direct effect of  $i^{\text{th}}$  character on yield (character 14)).

The solutions for path coefficients, direct and indirect effects of the causal factors were estimated as the values of the individual terms of the above equations in R.H.S.

The coefficient of determination ( $R^2$ ) and the residual effect ( $P_{13.R}$ ) were calculated as follows:

$$1 = p_{14.R}^2 + \sum p_{iy} r_{iy}$$

$$R^2 = \sum p_{iy} r_{iy} = p_{1.14} r_{1.14} + p_{2.14} r_{2.14} + \dots + p_{13.14} r_{13.14}$$

Hence,  $p_{14.R} = 1 - R^2$

The path analysis at the phenotypic level with the same cause and effect relationship was computed using the phenotypic correlations as stated earlier.

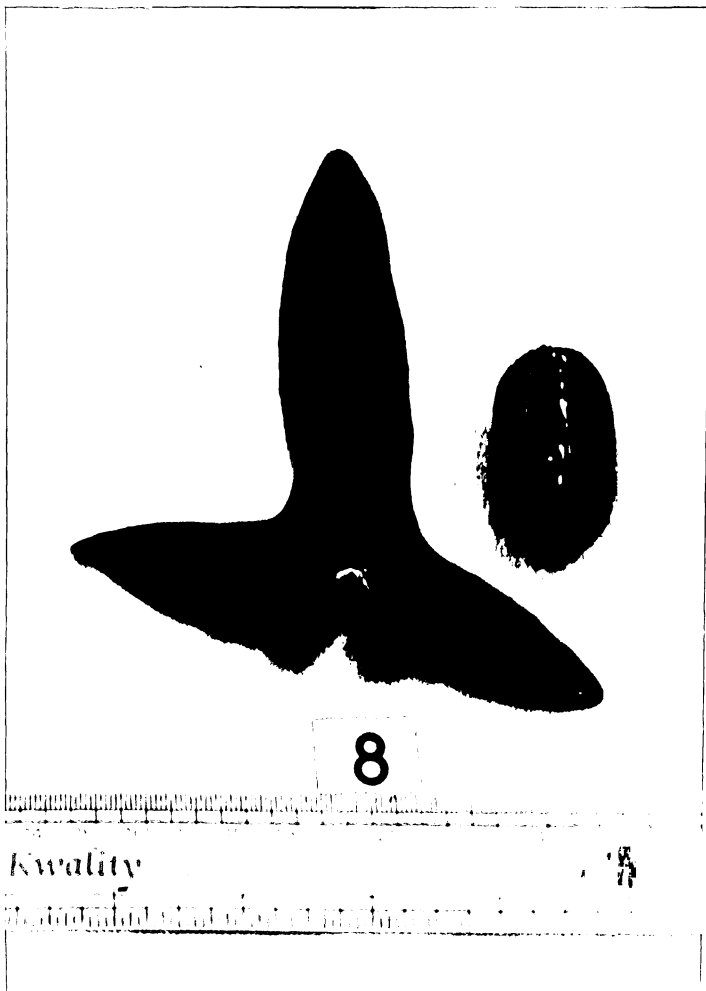
### Genetic divergence

After testing for difference between varieties for each of the 13 characters except yield a simultaneous test of significance of difference in mean values of the 14 correlated variables for the 15 genotypes was carried out using Wilk's Lambda ( $\lambda$ ) criterion (Wilks, 1932) and V- statistic (Rao, 1952).

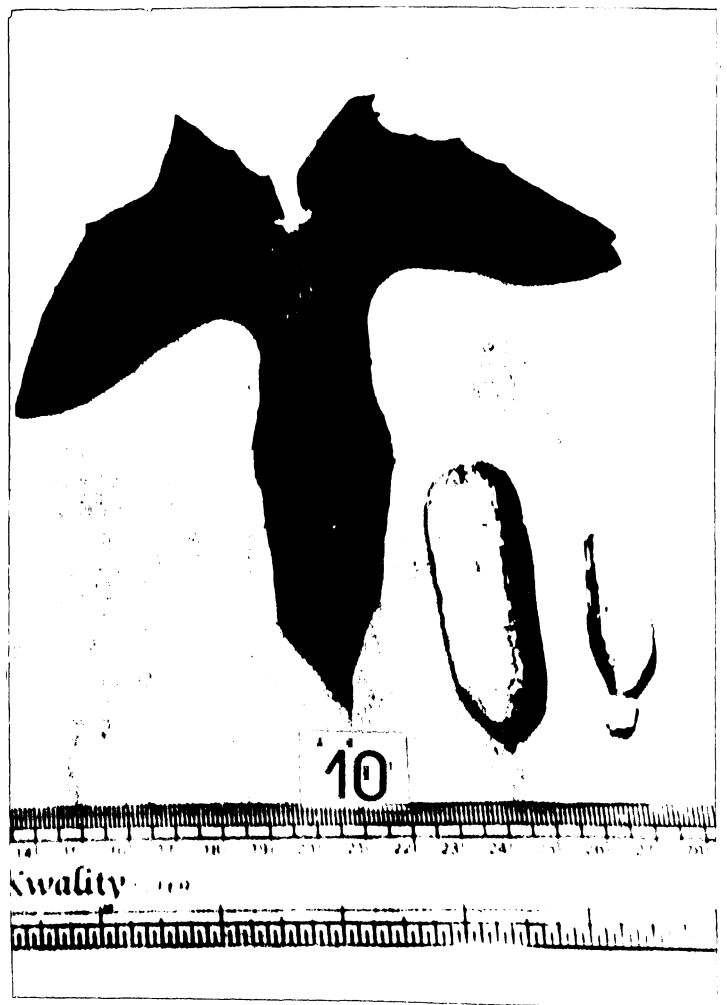
Genetic divergence was computed by using Mahalanobis generalized distance,  $D^2$ -statistic as described by Rao (1952). The original measurements were transformed to standardised un-correlated variables by pivotal condensation (Rao, 1952). The divergence between any two genotypes was obtained as the sum, of square of the differences in the values of the corresponding transformed values ( $Y_{ij}$ ).

$$D^2_{ij} = \sum_{i=1}^k (Y_{i1} - Y_{j1})$$

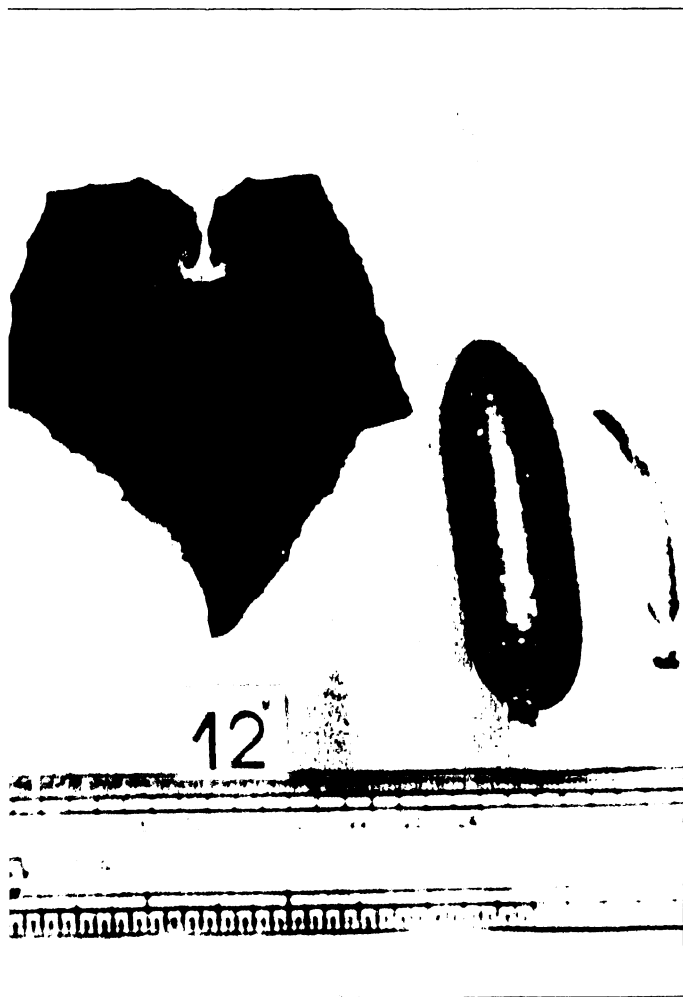
give the  $D^2$  between  $i^{\text{th}}$  and  $j^{\text{th}}$  cultivars for  $K$  characters . The all possible 55 pairs of  $D^2$  were calculated from 15 genotypes. Following Tocher's method as described by Rao (1952), the genotypes were grouped into clusters. Inter and intra-cluster distances were determined and their relationship was diagrammatically represented. Canonical analysis was done according to Anderson (1958). The divergence of 15 genotypes of *Melothria heterophylla* (Lour.) Cogn. was represented in a two dimensional graph using the first two canonical vectors ( $Z_1$  and  $Z_2$  ) as co-ordinates.



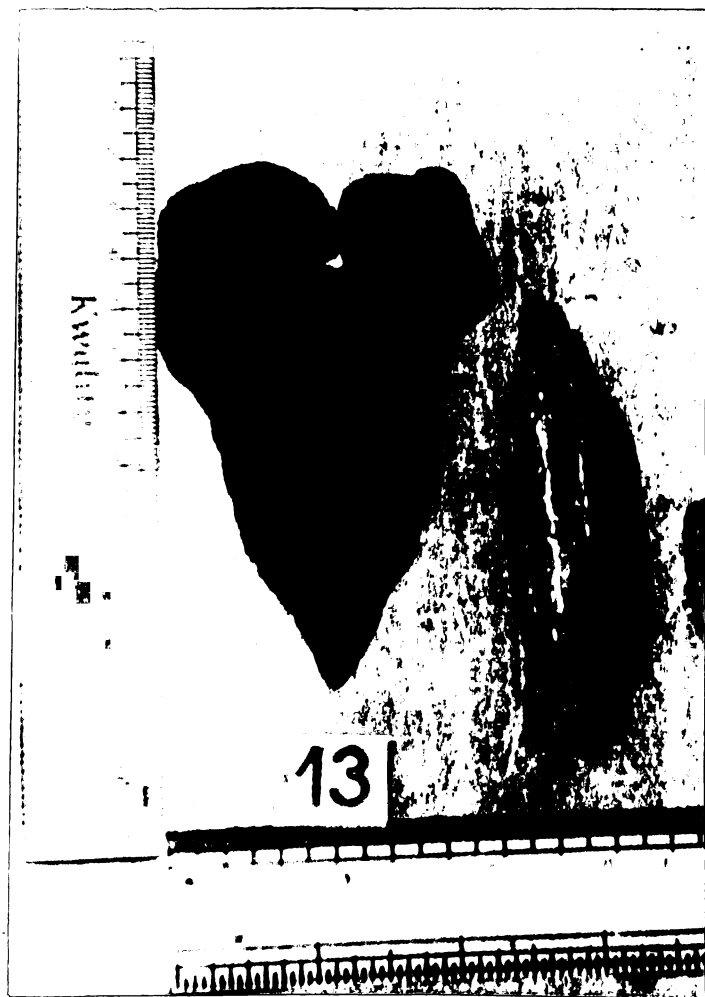
Edible fruit and leaf of genotype BMH-8.



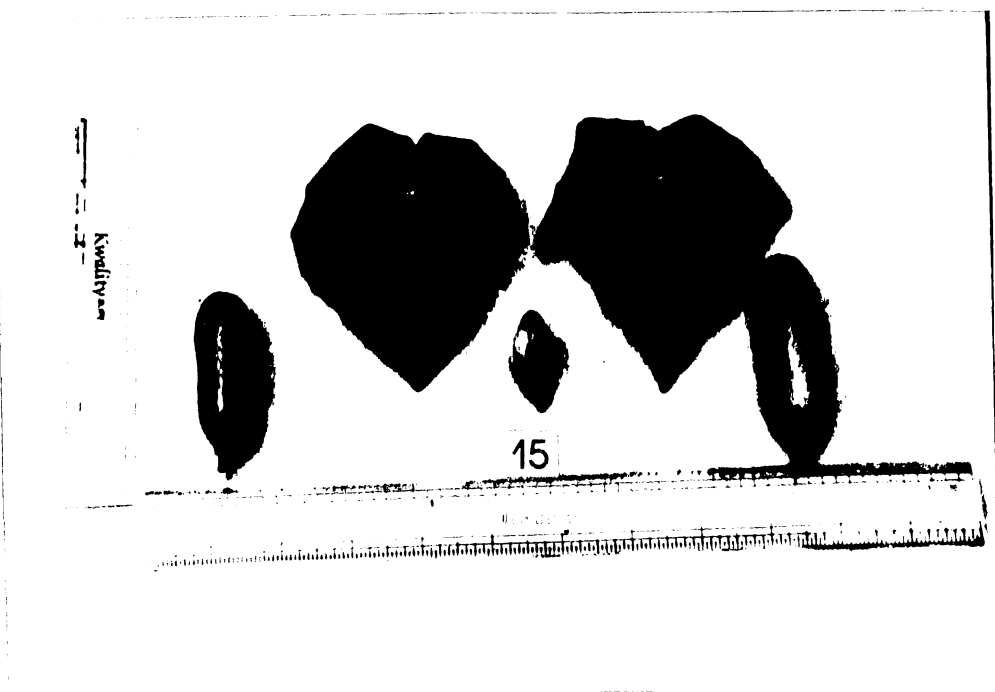
Edible fruit, immature fruit and leaf of genotype BMH-10



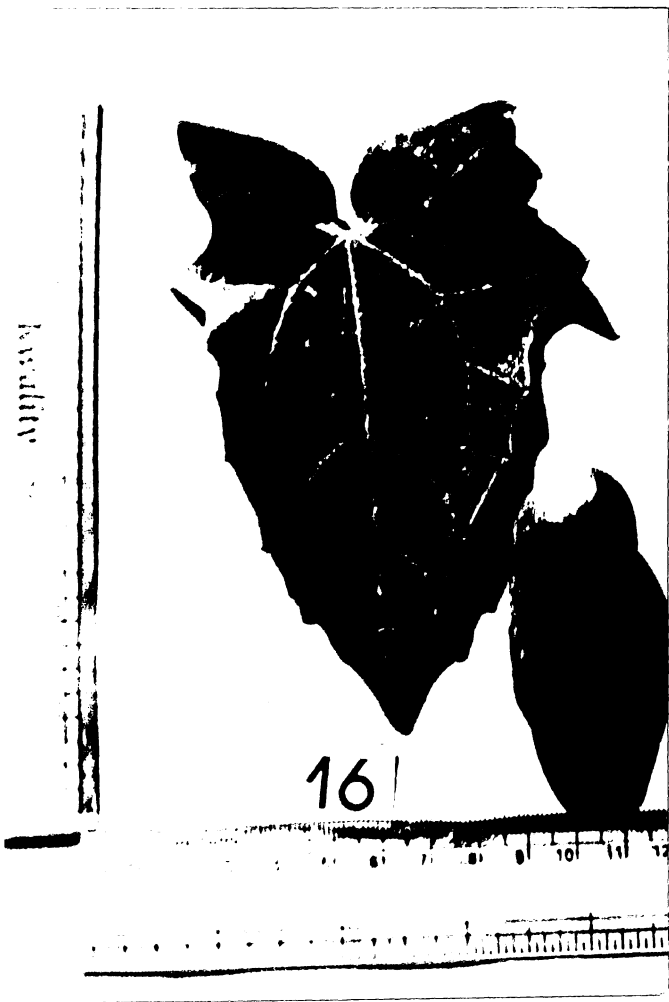
Edible fruit, immature fruit and leaf of genotype  
BMH-12



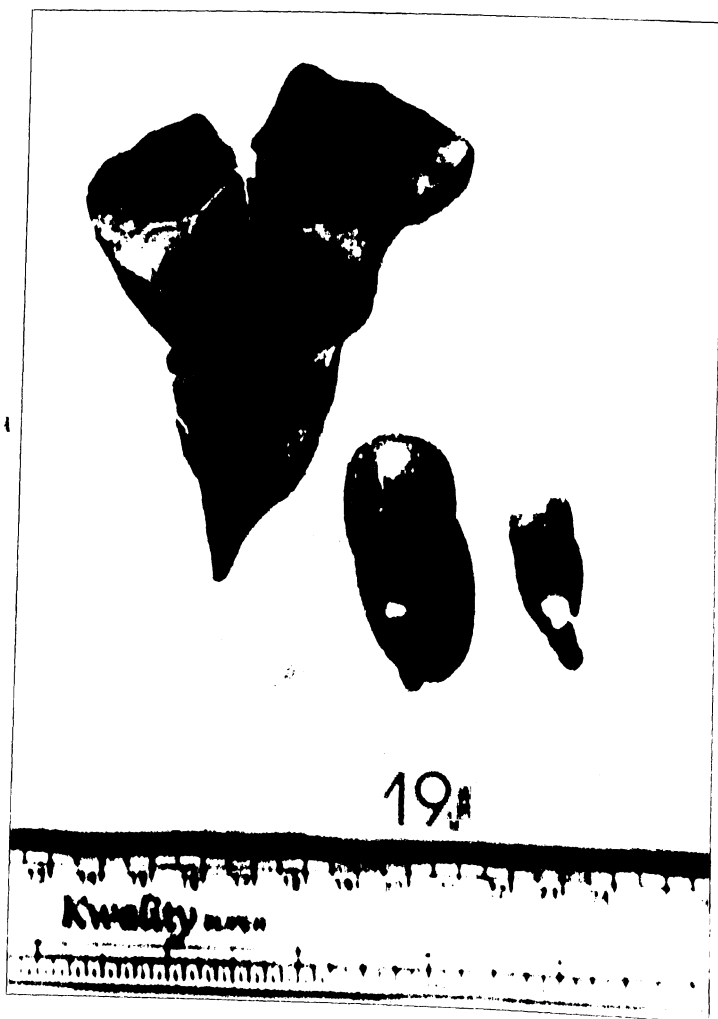
Edible fruit, immature fruit and leaf of genotype  
BMH-13



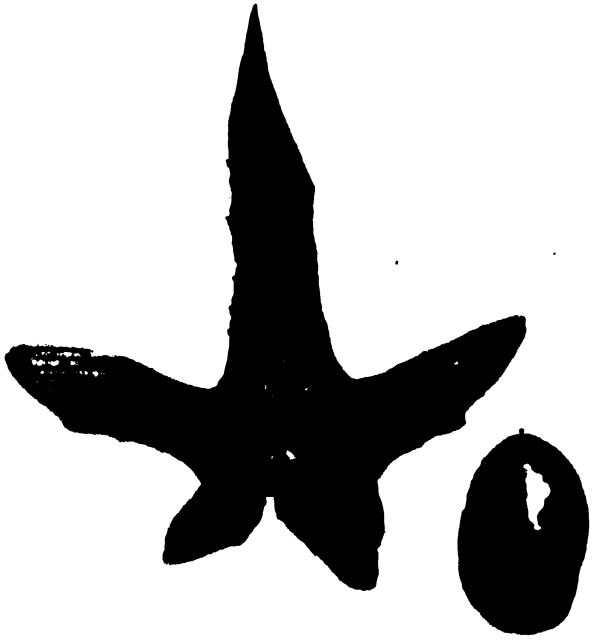
Edible fruit, immature fruit and leaf of genotype  
BMH-15



Edible fruit and leaf of genotype BMH-16



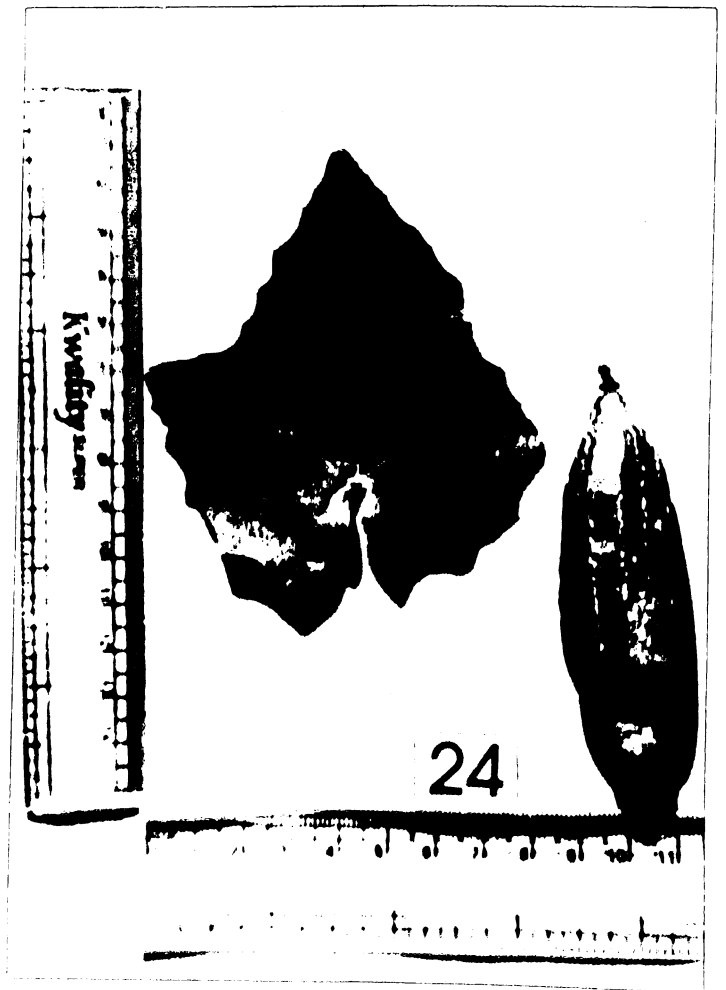
Edible fruit, immature fruit and leaf of genotype BMH-19



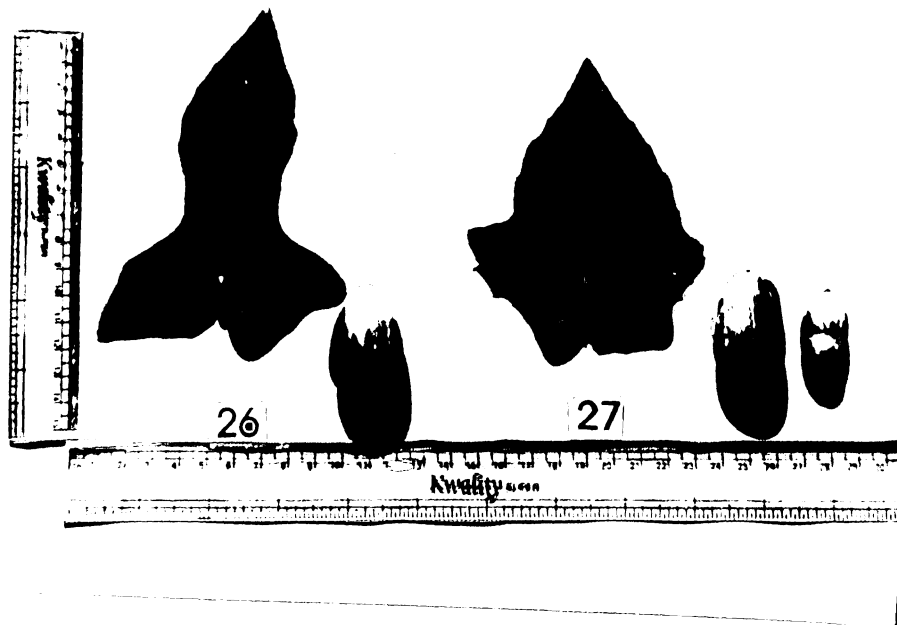
21

Kwality

Edible fruit and leaf of genotype BMH-21



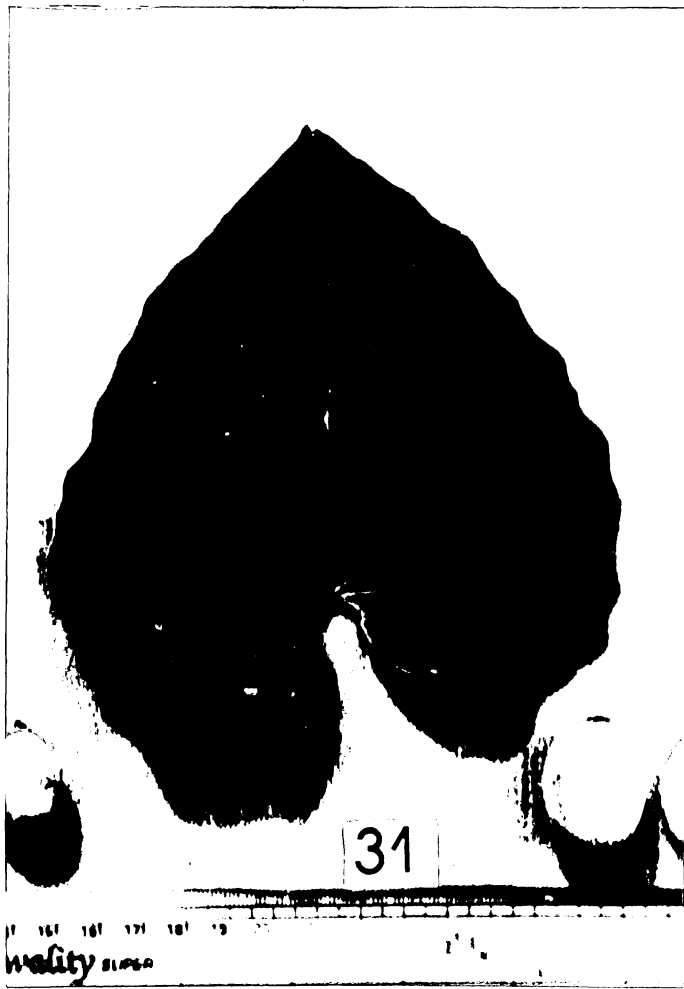
Edible fruit and leaf of genotype BMH-24



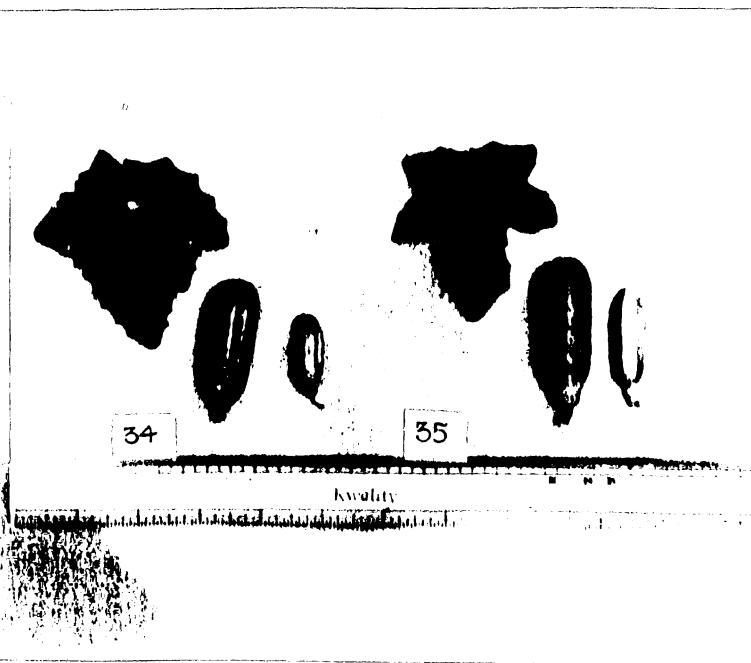
Edible fruits, immature fruits and leaves of genotype BMH-26 and BMH-27



Edible fruit and leaf of genotype BMH-28



Edible fruit, immature fruit and leaf of genotype BMH-31



Edible fruits, immature fruits and leaves of genotype BMH-34 and BMH-35

CHAPTER – IV

Results

# RESULTS

During the course of investigation of the project "Genetic variability in *Melothria heterophylla* (Lour) Cogn." numbers of observations on yield growth development etc. and related components were recorded. The mean values of various traits were subjected to suitable statistical analysis to study the variability, heritability and genetic gain for selection and their association with yield as well as among themselves. The direct and indirect effect on yield by these traits and the nature and extent of genetic divergence among different genotypes of *Melothria heterophylla* (Lour) Cogn. were also studied. The tables containing the analysed data and results are presented in this chapter.

## VARIABILITY STUDIES AND CHARACTER ASSOCIATION

The study of genetic variability and characters association in *Melothria heterophylla* (Lour) Cogn. genotypes was carried out and the results obtained are presented below.

### Analysis of variance

The variances (mean square values) between genotypes for 14 characters such as plant height, number of main branches, internodal length, leaf area, leaf lobe number, length of ovary before anthesis before anthesis, days taken for edible maturity, length of edible fruit, girth of edible fruit, number of seeds per fruit, seed weight of edible fruit, weight of edible fruit, number of fruits per plant, yield per plant were presented in Table-3. From the observed values significant difference among the genotypes for all the 14 characters studied were noticed.

### Plant height

The genotype BMH-16 was the tallest one followed by BMH-24 (4.05 mt.). The genotype BMH-21 was having the shortest plant height (1.29 mt.) BMH-13 (2.75 mt.) BMH-19 (2.84 mt.) BMH-27 (2.93mt.) BMH-28 (2.72 mt.) BMH-35 (2.82 mt.) were medium genotypes.

**Table-3. Mean performance of different genotypes *Melothria heterophylla* (Lour) Cogn.**

Type	Plant height (mt)	No. of main branches	Inter-nodal length (cm)	Leaf area (cm <sup>2</sup> )	Leaf lobe No.	Length of ovary (cm)	Days taken for edible maturity	Length of edible fruit (cm)	Girth of edible fruit (cm)	No. of seeds per fruit	Seed wt.. of edible fruit (gm)	Wt.. of edible fruit (gm)	No. of fruits per plant	Yield per plant (Kg)
BMH – 8	3.10	3.33	7.87	50.87	3.33	0.83	10.67	3.99	2.04	32.67	2.75	14.07	125.67	1.77
BMH – 10	3.45	6.67	11.66	50.36	4.67	0.93	9.00	5.00	2.05	43.33	3.52	12.27	128.00	1.57
BMH – 12	3.10	<u>7.33</u>	6.56	36.41	1.00	0.92	11.33	5.72	1.97	<u>51.67</u>	2.92	19.79	142.67	<u>2.82</u>
BMH – 13	2.75	4.67	10.66	40.25	1.00	0.85	<u>13.00</u>	<u>7.59</u>	2.08	49.00	3.44	17.55	126.33	2.32
BMH – 15	2.60	<u>7.33</u>	6.54	64.82	2.00	0.83	10.67	5.52	2.30	51.00	3.66	<u>21.47</u>	107.67	2.35
BMH – 16	<u>4.08</u>	5.33	11.04	69.58	2.33	1.01	10.00	4.92	2.23	34.00	3.32	20.22	118.00	2.39
BMH – 19	2.84	2.00	7.40	41.87	<u>5.00</u>	0.62	7.33	3.28	1.93	28.33	2.09	7.12	110.00	0.28
BMH – 21	1.92	4.00	6.74	29.24	1.00	0.62	7.00	3.28	1.92	17.33	1.08	6.08	109.67	0.67
BMH – 24	4.05	<u>7.33</u>	7.41	52.30	3.67	<u>1.13</u>	12.33	7.42	2.08	50.33	<u>4.25</u>	21.13	98.67	2.06
BMH – 26	2.32	5.33	11.70	62.44	1.00	0.87	9.33	4.08	<u>2.49</u>	32.67	3.24	15.82	109.33	1.73
BMH – 27	2.93	5.33	11.83	32.00	3.00	0.90	10.00	4.07	2.17	38.67	3.31	15.59	111.00	1.73
BMH – 28	2.72	5.33	12.11	57.59	1.00	0.82	10.00	4.50	1.93	40.67	3.04	12.15	128.00	1.59
BMH – 31	3.08	6.67	<u>13.64</u>	<u>125.79</u>	1.00	0.69	7.67	3.55	2.07	27.67	2.74	8.16	106.67	0.87
BMH – 34	2.51	5.67	9.09	34.37	1.00	1.00	12.00	6.86	2.20	45.67	5.23	18.46	118.33	2.18
BMH – 35	2.82	6.67	12.27	40.26	3.00	1.01	10.33	5.82	1.93	41.33	4.03	17.47	<u>149.33</u>	2.61
Mean	2.92	5.53	9.77	52.54	2.27	0.87	10.04	5.04	2.09	38.95	3.24	15.16	119.38	1.83
Range	1.92- 4.08	2.00- 7.33	6.54- 13.64	29.24- 125.79	1.00- 5.00	0.62- 1.13	7.00- 13.00	3.28- 7.59	1.92- 2.49	17.33- 51.67	1.08- 4.25	6.08- 21.47	98.67- 149.33	0.67- 2.82
SEM	0.04	0.63	0.13	1.04	0.16	0.02	0.25	0.01	0.06	1.16	0.10	0.21	2.57	0.04
SED	0.06	0.89	0.18	1.47	0.23	0.02	0.35	0.14	0.08	1.64	0.14	0.30	3.63	0.06
F-test	**	**	**	**	**	**	**	**	**	**	**	**	**	**
CD at 5%	0.12	1.83	0.36	3.01	0.48	0.05	0.72	0.28	0.17	3.36	0.28	0.62	7.44	0.12

\*\* Significant at 1% and 5% level.

### **Number of main branches**

Number of main branches produced per plants ranged from 2.00 to 7.33. The genotype BMH-12, BMH-15, BMH-24 produced highest number of branches (7.33) followed by BMH-10, BMH-31, BMH-35 (6.67). The genotype BMH-19 produced lowest number of main branches (2.00).

### **Internodal length**

The internodal length was significantly longest in BMH-31 (13.64 cm) and minimum internodal length as it was recorded in BMH-15 (6.54 cm), which remained at par with BMH-12 (6.56 cm) and BMH-21 (6.74 cm).

### **Leaf area**

The leaf area ranged from 29.24 sq.cms to 125.79 Sq. cms. The genotype BMH-21 produced leaves with lowest leaf area (29.24 sq. cms) followed by BMH-27 (32.00 sq. cms) where as largest leaf area was observed in BMH-31 (125.79 sq. cms) followed by BMH-16 (69.58 sq. cms). Medium values for this were obtained in BMH-25 (62.44 sq.cms), BMH-28 (57.59 sq. cms), BMH-8 (50.87 sq. cms), BMH-10, (50.36 sq. cms).

### **Leaf lobe number**

Maximum number leaf lobes were obtained in the genotype BMH-19 (5.00) followed by BMH-10 (4.67). Less number of lobes were recorded in BMH-12, (1.00), BMH-13 (1.00), BMH-21 (1.00), BMH-25 (1.00), BMH-28, (1.00), BMH-31 (1.00), BMH-34 (1.00).

### **Length of ovary before anthesis**

Ovary length was 0.62 cm as in BMH-19 and BMH- 21 where as it was 1.13 cm as noticed in BMH-24. Other genotypes like BMH-16 and BMH-35 (1.01 cm) also produced longer ovaries where as BMH-13 (0.85 cm) and BMH-25 (0.87 cm) exhibited medium ovaries.

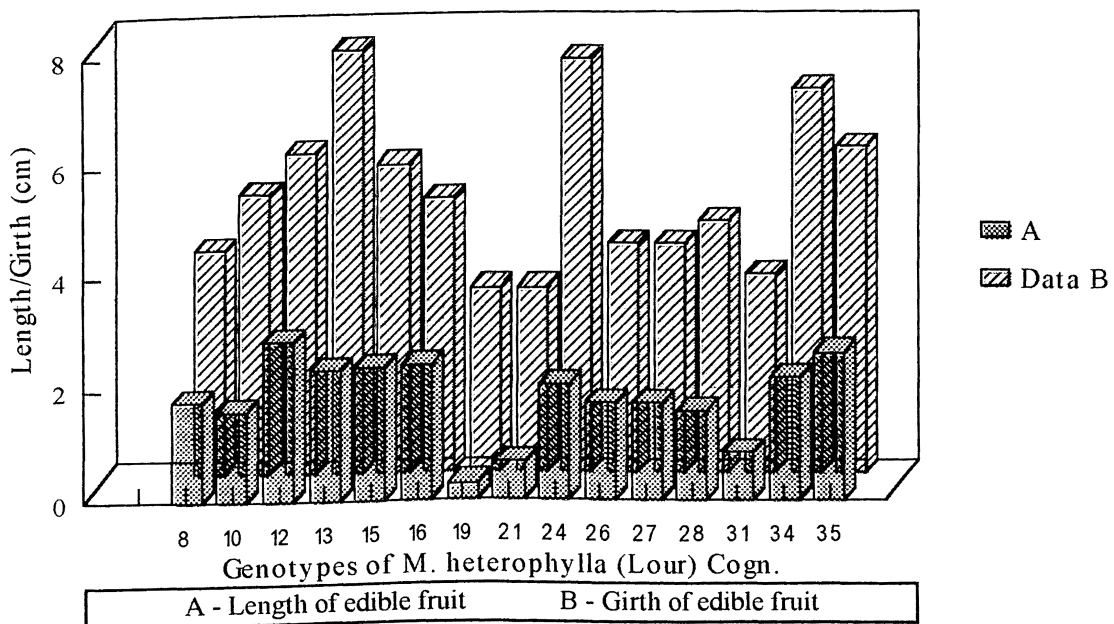
### Days taken for edible maturity

A range of 7.00 days to 13.00 days was observed among the genotypes to attain the edible maturity. The genotype BMH-21 was the earliest (7.00 days after anthesis) followed by BMH-10 (9.00 days). Genotype BMH-13 took longest days (13.00 days after anthesis), closely followed by BMH-24 (12.30 days after anthesis). Medium maturing genotypes were BMH-12, BMH-8, BMH-35, BMH-16, BMH-27, BMH-28 requiring 11.33 days, 10.67 days, 10.33 days, 10.00 days, 10.00 days 10.00 days respectively.

### Length of edible fruit

Maximum fruit length was recorded in BMH-13 (7.59 cm) followed by BMH-24 (7.42 cm). Minimum fruit length was recorded in BMH-19 and BMH-21 (3.28 cm) which remained at par with BMH-31 (3.55cm) and BMH-8 (3.99 cm) (Fig. 1).

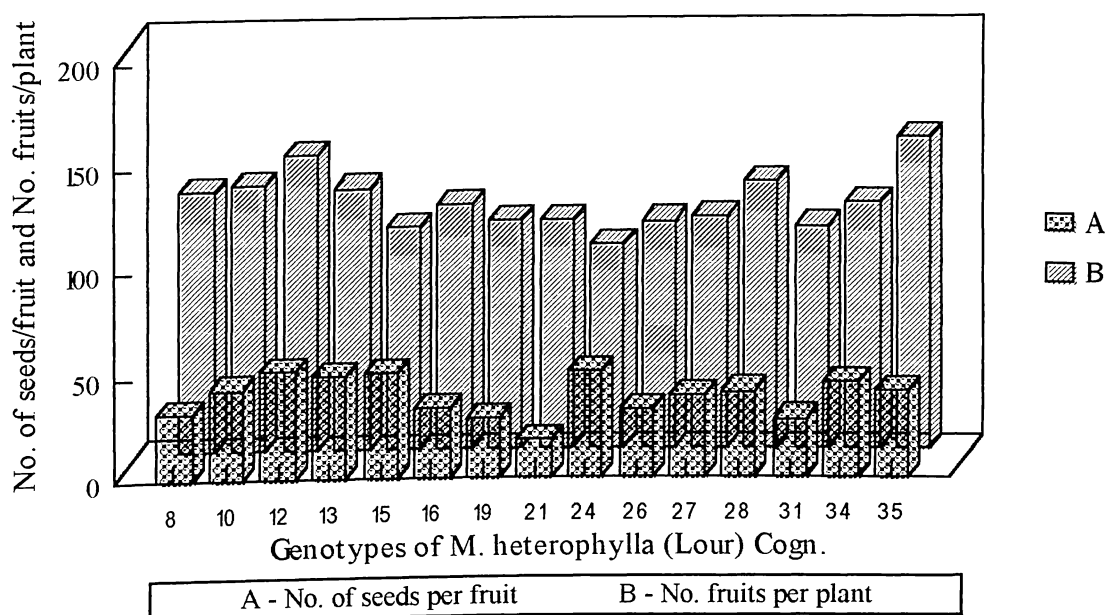
**Fig.1 Length and girth of edible fruit (cm).**



### Girth of edible fruit

Shortest fruit girth (1.92 cm) was observed in genotype BMH-21 and highest fruit girth (2.44 cm) was noticed in BMH-16. BMH-19 and BMH-35 produced fruit of equal girth (1.93 cm). BMH-15 (2.30 cm) produced recorded fruit girth in higher side. Medium fruit girth was noticed in BMH-31 (2.07 cm), BMH-24 (2.08 cm), BMH-13 (2.08cm) (Fig.1).

**Fig.2 Number of seeds per fruit and number of fruits per plant.**



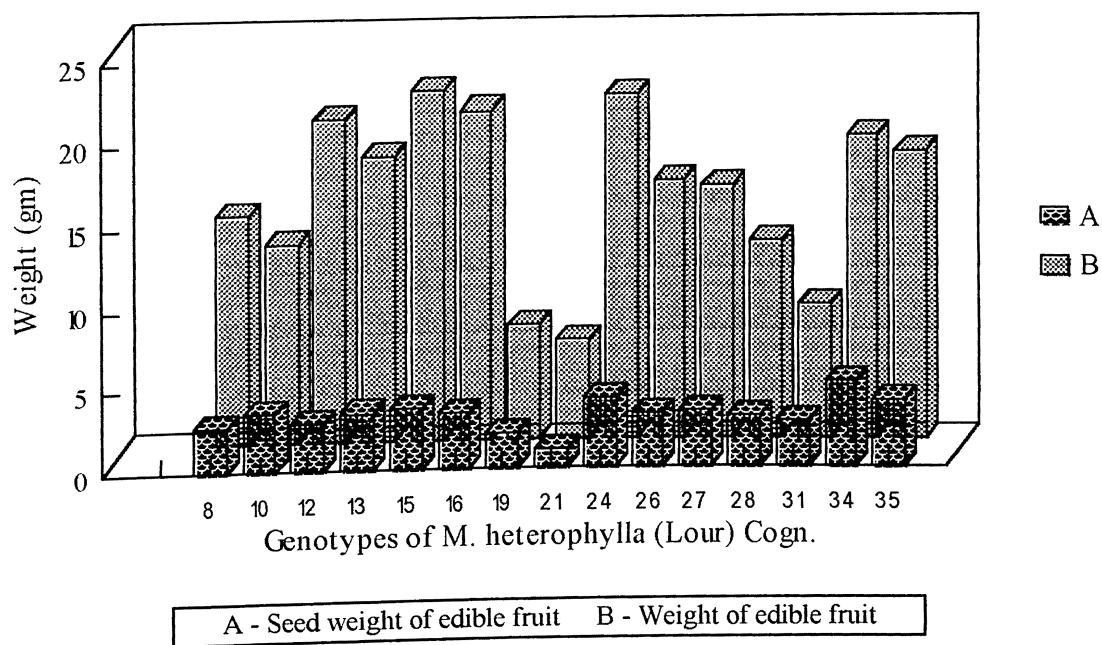
### Number of seeds per fruit

A wide range (17.33 to 51.67) was observed for 'number of seeds per fruit'. The genotype BMH-12 produced 51.67 number of seeds per fruit followed by BMH-15 (51.00), BMH-24 (50.33) and BMH-13 (49.00). The genotype BMH-21 produced the lowest number of seeds per fruit (17.33). Moderate values were obtained in BMH-16, BMH-27 i.e., 34.00, 38.67 respectively (Fig.2).

### Seed weight of edible fruit

Seed weight ranged from 1.08 gms to 4.25 gms among the genotypes under study. The genotype BMH-24 recorded the highest seed weight closely followed by BMH-35 (4.03 gms). Lowest seed weight was noticed in BMH-21 (1.08) followed by BMH-19 (2.09 gms). Moderate values were obtained in genotypes like BMH-26 (3.24 gms), BMH-27 (3.31 gms), BMH-16 (3.32 gms) (Fig.3).

**Fig. 3 Seed weight of edible fruit and weight of edible fruit (gm).**



### Weight of edible fruit

Considerable variation was observed for fruit weight ranging from 6.08 gm to 21.47 gm among the genotypes. The genotype BMH-21 had the lowest fruit weight (6.08 gm) and BMH-15 (21.47 gm) had the highest fruit weight. The genotypes BMH-26 (15.82 gm) and BMH-27 (15.59 gm) were having medium fruit weight (Fig.3).

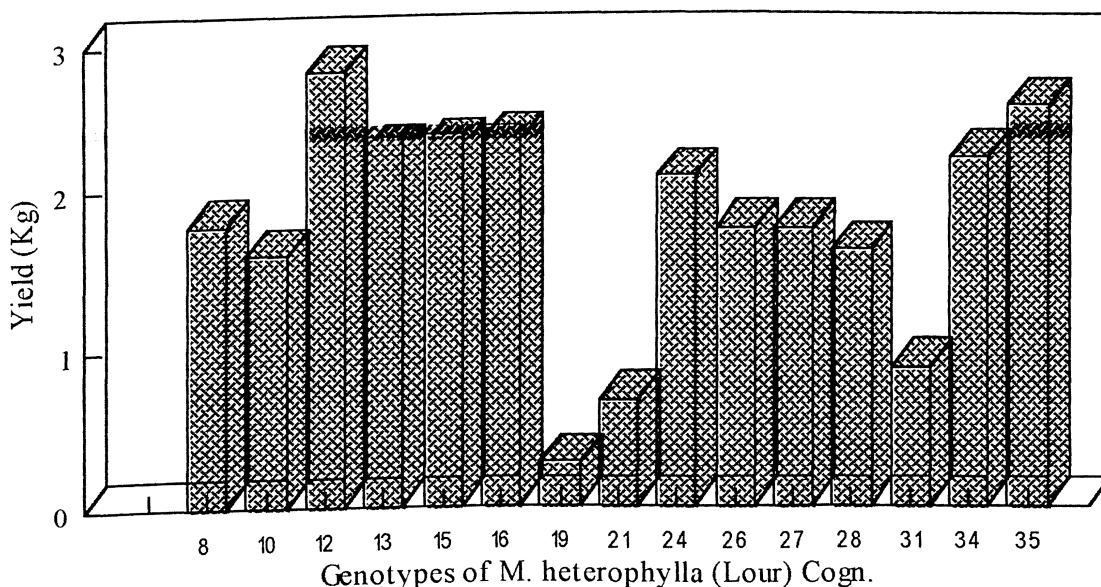
### Number of fruits per plant

Number of fruits per plant varied from 98.67 to 149.33. Lowest number of fruits was seen in BMH-24 (98.67) followed by BMH-31 (106.67), BMH-26 (109.33), BMH-21 (109.67). The genotype BMH-35 yielded highest number of fruits per plant (149.33). The genotypes BMH-34, BMH-16 were having 118.00 and 118.33 fruits per plant respectively (Fig.2).

### Yield per plant

A significant difference for yield per plant was observed among genotypes. It ranged from 0.67 kg as in BMH-21 to 2.82 kg as in BMH-12. The genotypes such as BMH-8 (1.77 kg), BMH-24 (2.06 kg) were the medium yielders. Other genotypes showing yield at lower side close to the lowest yielding genotypes BMH-19 (0.78 kg), BMH-31 (0.87 kg) (Fig.4).

**Fig.4 Fruit yield per plant (Kg).**



Besides these 14 characters some other characters were also observed for variability studies. Though these characters were not considered for correlation and D<sup>2</sup> analysis but they shows some difference among the genotypes and the results for these characters are given below.

### Mean performance

The mean performance of different characters except 14 characters stated above are presented in Table-4.

### Girth of stem

The genotype BMH-21 (0.16 cm) had the smallest girth followed by BMH-19 (0.17 cm). The genotypes BMH-34, BMH-35 produced the highest girth.

**Number of nodes for branching**

BMH-13 produced branching at lowest point where as genotype BMH-12 and BMH-15 produced braching at higher nodes (6.67).

**Branching height**

Highest branching height was found in BMH-8 (7.70 cm) & lowest BMH-31 (0.73 cm).

**Days taken for opening of flower**

Highest number of days were required for opening of flower in BMH-12 (7.83) and lowest was found in BMH-21 (6.17).

**Days taken for ripening of fruit**

The genotype BMH-12 (31.00) was taken highest day for ripening of fruit and lowest (12.67) in BMH-19 and BMH-21.

**Cluster of flower**

In genotype BMH-13, 1.67 flowers were produced per cluster and in other case it was only one.

**Table-4. Mean performance of different genotypes of *Melothrial heterophylla* (Lour) Cogn.**

Character Type	Girth of stem (cm)	No. of nodes for branching	Branching height (cm)	Days taken for opening of flower	Days taken for ripening of fruit	Cluster of flower	Tenderness of leaf *	Colour of leaf **	Leaf length (cm)	Leaf width (cm)	Leaf thickness (cm)	Girth of ovary (cm)	Maximum fruit length (cm)
BMH-8	0.23	4.33	7.70	6.67	25.33	1	2.10	4.33	10.27	11.93	0.040	0.26	4.65
BMH-10	0.23	3.67	1.87	7.00	24.67	1	3.27	4.00	9.80	12.23	0.028	0.32	5.12
BMH-12	0.28	6.67	1.80	7.83	31.00	1	2.07	4.13	7.53	6.60	0.023	0.34	6.64
BMH-13	0.25	2.00	2.23	6.67	27.33	1.67	3.17	3.63	7.40	6.27	0.040	0.29	8.37
BMH-15	0.29	6.67	2.07	6.83	24.33	1	3.50	4.97	9.00	10.37	0.040	0.26	6.20
BMH-16	0.22	3.00	3.97	7.00	27.00	1	4.33	4.80	10.37	9.27	0.041	0.31	5.40
BMH-19	0.17	4.67	5.73	6.50	23.67	1	3.03	3.63	8.17	8.40	0.031	0.20	3.42
BMH-21	0.16	3.33	1.63	6.17	23.67	1	2.90	4.67	9.23	9.10	0.030	0.29	3.34
BMH-24	0.28	2.67	1.67	7.33	28.67	1	2.27	4.07	9.57	9.17	0.020	0.36	7.81
BMH-26	0.19	6.33	1.00	7.33	25.33	1	2.00	5.37	10.33	9.53	0.030	0.33	4.14
BMH-27	0.20	4.33	5.13	7.33	27.67	1	3.07	5.40	6.60	6.17	0.025	0.37	4.17
BMH-28	0.25	3.33	1.27	7.17	26.67	1	4.37	4.10	9.80	9.10	0.030	0.23	4.75
BMH-31	0.29	3.67	0.73	6.83	25.33	1	1.90	4.03	11.63	12.33	0.036	0.31	3.81
BMH-34	0.30	3.33	2.40	7.00	27.67	1	3.00	4.17	6.90	7.20	0.026	0.35	7.85
BMH-35	0.30	2.67	3.57	6.83	29.67	1	3.17	4.23	6.37	8.07	0.034	0.34	6.04

\* More rough-4,

Rough-3,

Slight rough-2

\*\* Dark green-5,

Green-4,

Light green-3

**Table-4 (contd....)**

Characters/ Type	Maximum fruit girth (cm)	Seed wt. at over mature stage (gm)	Seed wt. at ripening stage (gm)	Ridge number	First fruiting height (mt)	Fruit wt. at over mature stage (gm)	Fruit wt. at ripening stage (gm)	Colour of edible fruit *	Keeping quality of immature fruit (day)	Keeping quality of edible fruit (day)	Loss of cut of fruit (gm)			
											0 day	5th day	10th day	15th day
BMH – 8	2.11	3.17	4.07	10	1.29	15.22	17.06	5.30	10.67	14.33	14.79	13.75	12.77	11.94
BMH – 10	2.09	4.38	5.38	10	0.84	14.30	16.30	2.90	13.00	16.33	12.27	11.25	10.43	9.73
BMH – 12	2.21	3.96	5.30	1	1.05	20.83	22.58	2.20	10.67	14.67	19.79	18.66	17.64	16.67
BMH – 13	2.16	4.69	5.10	10	1.32	18.47	20.99	5.27	14.67	19.33	19.20	17.69	17.37	16.54
BMH – 15	2.36	4.76	6.20	10	1.32	23.23	25.85	4.10	10.33	16.33	21.47	19.59	19.03	19.57
BMH – 16	2.39	4.10	4.08	10	1.42	21.27	23.49	5.10	12.33	17.33	20.22	19.40	18.58	17.90
BMH – 19	2.07	3.08	4.56	10	0.81	7.91	9.55	4.97	16.67	22.67	7.25	6.13	5.83	5.21
BMH – 21	2.01	1.28	1.81	10	1.03	6.85	7.90	4.27	10.00	18.00	6.38	5.75	4.81	4.25
BMH – 24	2.24	5.40	7.67	10	1.11	22.47	26.35	2.83	10.00	13.67	21.13	20.15	19.32	18.73
BMH – 26	2.58	4.25	5.22	10	1.09	16.90	19.15	5.00	16.33	22.33	15.59	14.62	13.77	13.08
BMH – 27	2.32	4.96	5.65	1	1.19	17.19	19.21	4.40	10.67	15.33	15.59	14.72	13.63	12.92
BMH – 28	2.21	3.54	4.30	10	1.21	13.17	14.87	5.03	11.33	15.67	11.81	10.84	10.14	9.63
BMH – 31	2.18	3.31	4.17	1	1.22	9.57	10.22	2.77	9.33	15.33	8.14	7.32	6.64	6.18
BMH – 34	2.26	6.36	7.67	10	1.37	20.50	22.53	5.50	9.67	15.33	18.52	17.61	16.73	16.03
BMH – 35	2.07	4.81	6.85	10	1.26	18.63	19.83	4.03	13.67	20.00	16.10	16.61	15.99	15.50

\* Dark green-5, Green-4, Light green-3.

**Leaf length**

Leaf length was highest in BMH-8 (10.27 cm). Lowest leaf length was found in BMH-35 (6.37 cm).

**Leaf width**

Highest leaf width was found in BMH-31 (12.33 cm) and lowest in BMH-27 (6.17 cm).

**Girth of ovary before anthesis**

Highest ovary length was observed in BMH-27 (0.37 cm) followed by BMH-24 (0.36 cm) where lowest was seen in BMH-19 (0.20 cm).

**Maximum fruit length**

Length of fruit was highest in BMH-13 (8.37 cm) where as lowest was seen in BMH-21 (3.34 cm).

**Maximum fruit girth**

The genotype BMH-26 (2.58 cm) had highest fruit girth and genotype BMH-21 (2.01 cm) had the lowest fruit girth.

**Seed weight at over matured stage**

Seed weight in over matured fruits was highest in genotype BMH-34 (6.36 gm) & lowest in BMH-21 (1.28 gm).

**Ridge number**

In all genotypes the ridge number in fruits was 10 but no ridges were seen in BMH-12, BMH-27, BMH-31.

**First fruiting height**

First fruiting height was at 1.42 mt. in genotype BMH-16, where as BMH-19 produced fruits at lowest point (0.81 mt.).

### **Fruit weight at over mature stage**

Highest fruit weight in over mature stage was seen in genotype BMH-15 (23.23 gm) followed by BMH-24 (22.47gm) and lowest was seen in BMH-21 (6.85 gm).

### **Keeping quality of fruits at edible maturity**

The edible fruit of genotype BMH-19 (22.67) lasted for more days where as BMH-24 lasted for least days (13.67).

### **Coefficient of variation (C.V.)**

The coefficient of variation with respect to the different characters are presented in Table-5 which ranged from 2.22% to 19.76%. The highest variation was noticed in number of main branches (19.76%) followed by leaf lobe number (12.56%), seed weight at stage (5.22%). The lowest variation was found in internodal length (2.22%) followed by weight of edible fruit (2.45%) and plant height (2.50%) in ascending order. Thus on the basis of C.V. value, the characters could be grouped into classes such as (i) low variability (C.V.= 10% or less), (ii) moderate variability (C.V. = 10-15%) and (iii) high variability (C.V. = 15-20%).

The traits except leaf lobe number and number of mainbranches exhibited low variability. Further the trait leaf lobe number exhibited moderate variability and number of main branches exhibited high variability.

### **Estimation of genetic parameter**

The estimation of genetic parameters such as genotypic variance and phenotypic variance and their respective co-efficient of variation, broad sense heritability and genetic gain for selection are presented in Table-5.

The genotypic variance was 0.02 for length of ovary before anthesis before anthesis and girth of edible fruit. It was 563.84 for leaf area and phenotypic variance was 0.02 for length of ovary before anthesis before anthesis and girth of edible fruit to 564.92 for leaf lobe number. In general all the traits exhibited parallelism values between these two variances showing lower value in the former than later.

Table-5. Mean, Range, CV, GV, PV, PCV, GCV, heritability. GA as percent of mean for different characters.

Sl. No.	Characters	Mean	Range	CV	GV	PV	Heritability (%)	Variability (%)		Genetic advance	GA A& % of mean
								PCV	GCV		
1	Plant height (mt)	2.92	1.92-4.08	2.50	0.36	0.36	98.50	20.63	20.48	1.22	41.78
2	Number of main branches	5.53	2.00-7.33	19.76	2.04	2.44	63.20	32.52	25.83	2.34	42.31
3	Internodal length (cm)	9.77	6.54-13.64	2.22	6.12	6.13	99.20	25.42	25.32	5.08	51.99
4	Leaf area (cm <sup>2</sup> )	52.54	29.24-125.79	3.42	563.84	564.92	99.40	45.32	45.19	48.78	92.84
5	Leaf lobe number	2.27	1.00-5.00	12.56	2.02	2.05	96.20	64.00	62.76	2.87	126.43
6	Length of ovary (cm)	0.87	0.62-1.13	3.17	0.02	0.02	96.60	17.08	16.78	0.30	34.48
7	Days taken for edible maturity	10.04	7.00-13.00	4.27	3.10	3.15	94.40	18.03	17.52	3.52	35.06
8	Length of edible fruit (cm)	5.04	3.28-7.59	3.30	2.03	2.04	98.70	28.43	28.24	2.91	57.74
9	Girth of edible fruit (cm)	2.09	1.92-2.49	4.93	0.02	0.02	65.40	8.38	6.77	0.24	11.48
10	Number of seeds per fruit	38.95	17.33-51.67	5.15	100.18	101.52	96.10	26.20	25.69	20.22	51.91
11	Seed wt. of edible fruit (gm)	3.24	1.08-4.25	5.22	0.89	0.90	96.90	29.51	29.05	1.91	58.95
12	Weight of edible fruit (gm)	15.16	6.08-21.47	2.45	25.67	25.77	99.50	33.52	33.43	10.41	68.67
13	Number of fruits per plant	119.29	98.67-149.33	3.73	109.57	197.16	90.60	12.16	11.57	27.07	22.69
14	Yield per plant (Kg)	1.83	0.67-2.82	4.02	0.43	0.47	98.80	36.24	36.02	1.35	73.77

The phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all the traits. The PCV was highest for leaf lobe number (64.00%) followed by leaf area (45.32%) yield per plant (36.24%) and weight of edible fruit (33.52%). Comparative moderate values between 32.52 to 20.36 % were found for the characters namely, number of main branches, seed weight of edible fruit, length of edible fruit, number of main branches, number of seeds per fruit, internodal length, plant height. The other traits had low values for this parameter and lowest for girth of edible fruit (8.38%).

The leaf lobe number and girth of edible fruit recorded highest (62.76%) and lowest (6.77%) genotypic coefficient variation (GCV). More or less similar trend of GCV was observed in this estimate for rest of the characters.

### **Heritability**

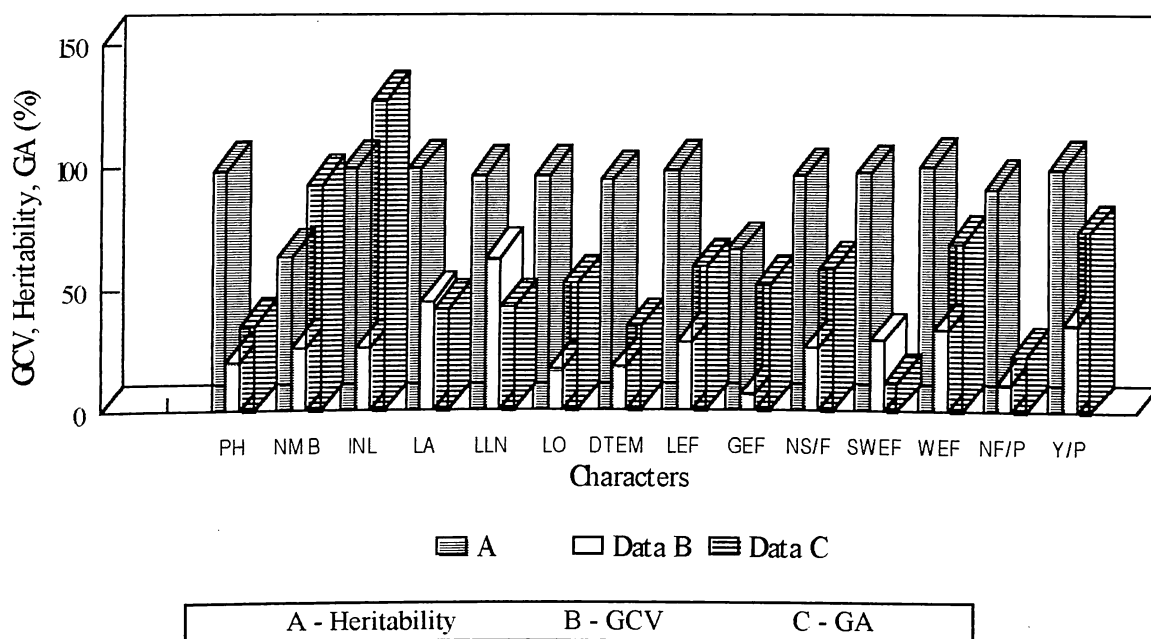
High heritability values were observed for all the 14 characters except number of main branches and girth of edible fruit, which ranged from 63.1% in number of main branches to 99.5% in weight of edible fruit. Less than 90% heritability was observed in number of main branches (63.1%) and girth of edible fruit (65.4%).

### **Genetic advance**

The genetic advance varied from 0.30 to 48.78. The highest estimate was obtained for leaf area and lowest for length of ovary before anthesis. Other characters showing high genetic advance value were number of fruits per plant (27.07) number of seeds per fruit (20.22). The rest characters showed low values for this parameter.

The expected genetic gain by selection was determined by estimating genetic advance as percentage of mean which ranged from 11.48% for girth of edible fruit to 126.43% for leaf lobe number. The characters like leaf area, yield per plant, weight of edible fruit exhibited high values of 92.84%, 73.77% and 68.67% respectively, while remaining traits had intermediate values.

**Fig.5 Genotypic coefficient of variation, heritability & genetic advance of quantitative characters in *M. heterophylla* (Lour) Cogn.**



### Character association

Tables - 6 & 7 shows the genotypic and phenotypic correlation coefficients involving 14 characters. These were estimated from the pooled analysis of variances and covariances. There were altogether 91 sets of estimates and in almost all the sets the genotypic correlation coefficients ( $r_g$ ) were of higher magnitude than phenotypic correlation coefficients ( $r_p$ ). This exhibited that association between characters were greatly influenced by environmental changes.

In as many as 30 sets, genotypic coefficients were significant and in 25 of 30 sets, phenotypic coefficients were also significant and these mostly involved yield and its components. Thus, association of yield with its components was stronger when the sample estimates in yield were dependable. The estimates for yield showed positive and significant  $r_p$  with the six components such as days taken for edible maturity, length of ovary before anthesis, seed weight of edible fruit, number of seeds per fruit, length of edible fruit, weight of edible fruit and positively significant  $r_g$  with above six character plus number of main branches.

Table-6. Genotypic correlation coefficient of different characters of *Melothria heterophylla* (Lour) Cogn.

Character	Days taken for edible maturity	Leaf area (cm <sup>2</sup> )	Leaf lobe No.	Plant height (mt)	No. of main branches	Inter-nodal length (cm)	Length of ovary (cm)	Seed wt. of edible fruit (gm)	No. of seeds per fruit	Length of edible fruit (cm)	Girth of edible fruit (cm)	Wt. of edible fruit (gm)	No. of fruits per plant	Yield per plant (Kg)
1	0	-0.288	-0.563*	0.371	0.422	-0.130	-0.751**	0.741**	0.857**	0.908**	0.244	0.846**	0.262	0.827*
2		0	-0.190	0.283	0.295	0.453	-0.182	-0.040	-0.205	-0.256	0.274	-0.151	-0.323	-0.245
3			0	-0.284	-0.388	0.468	-0.305	-0.483	-0.566*	-0.500	-0.247	-0.541*	0.163	-0.439
4				0	0.464	0.157	0.674*	0.380	0.376	0.359	0.066	0.483	0.021	0.396
5					0	0.171	0.640*	0.612*	0.695**	0.550*	0.296	0.640**	0.167	0.603*
6						0	0.103	0.205	-0.126	-0.123	0.156	-0.148	0.177	-0.068
7							0	0.831**	0.697**	0.735**	0.319	0.837**	0.240**	0.780
8								0	0.740**	0.758**	0.448	0.736**	0.137	0.665**
9									0	0.839**	0.185	0.808**	0.308	0.805**
10										0	0.117	0.754**	0.219	0.733**
11											0	0.521	-0.484	0.276
12												0	0.175	0.925**
13													0	0.528
14														0

d.f = 12, 5% = 0.532, 1% = 0.661.

\* Significant at 1% level,

\*\* Significant at 5% level.

Table-7. Phenotypic correlation coefficient of different characters of *Melothria heterophylla* (Lour) Cogn.

Character	Days taken for edible maturity	Leaf area (cm <sup>2</sup> )	Leaf lobe No.	Plant height (mt)	No. of main branches	Inter-nodal length (cm)	Length of ovary (cm)	Seed wt. of edible fruit (gm)	No. of seeds per fruit	Length of edible fruit (cm)	Girth of edible fruit (cm)	Wt. of edible fruit (gm)	No. of fruits per plant	Yield per plant (Kg)
1	0	-0.283	-0.528	0.357	0.319	-0.525	0.714**	0.707**	0.813**	0.872**	0.191	0.821**	0.249	0.822**
2		0	-0.189	0.279	0.245	0.449	-0.175	-0.041	-0.195	-0.257	0.206	-0.150	-0.311	-0.244
3			0	-0.277	-0.274	0.065	-0.287	-0.467	-0.545*	-0.492	-0.229	-0.532*	0.160	-0.426
4				0	0.388	0.358	0.658*	0.362	0.360	0.354	0.068	0.477	0.018	0.388
5					0	0.129	0.539	0.440	0.535*	0.403	0.149	0.495	0.102	0.457
6						0	0.100	0.202	-0.125	-0.118	0.118	-0.147	0.155	-0.071
7							0	0.805**	0.673**	0.713**	0.232	0.819**	0.223	0.762**
8								0	0.718**	0.745**	0.346	0.728**	0.127	0.657*
9									0	0.815**	0.156	0.796**	0.282	0.787**
10										0	0.124	0.748*	0.195	0.721**
11											0	0.425	-0.360	0.229
12												0	0.164	0.922**
13													0	0.524
14														0

\* Significant at 1% level,

\*\* Significant at 5% level.

The mean yield per plant showed highly significant genotypic correlation with six components like days taken for edible maturity (0.827) , length of ovary before anthesis before anthesis (0.780), seed weight of edible fruit (0.665), number of seeds per fruit (0.805), length of edible fruit (0.733) and weight of edible fruit (0.925). All are significant at 1% level. Also yield exhibited significant genotypic correlation with number of main branches (0.603) at 5% level. Yield also highly positive and significant phenotypic correlation with days taken for edible maturity (0.802), length of ovary before anthesis before anthesis (0.762), seed weight of edible fruit (0.657), number of seeds per fruit (0.787), length of edible fruit (0.721) and weight of edible fruit (0.922). All are significant at 1% level, yield per plant did not show any significant correlation either at genotypic or phenotypic level with rest of the characters. Weight of edible fruit showed highly significant correlation at 1% level for ( $r_g$ ) and for ( $r_p$ ) with days taken for edible maturity, number of main branches, length of ovary before anthesis before anthesis, seed weight of edible fruit, number of seeds per fruit and length of edible fruit. On the other hand weight of edible fruit showed negatively significant correlation at 5% level both for ( $r_g$ ) and ( $r_p$ ) with leaf lobe number. Number of fruits did not show any significant correlation with any other characters. Edible fruit girth showed no significant correlation with any other characters, in this case all the characters positively correlated except leaf lobe number. The length of edible fruit showed highly significant correlation, at 1% level for ( $r_g$ ) and ( $r_p$ ) with days taken for edible maturity, length of ovary before anthesis, seed weight of edible fruit, number of seeds per fruit. Length of edible fruit positively correlated with other character except with leaf area, leaf lobe number and internodal length. Number of seeds per fruit showed highly significant correlation at 1% level for ( $r_g$ ) with days taken for edible maturity (0.857), number of main branches (0.695), length of ovary before anthesis before anthesis (0.697) and seed weight of edible fruit (0.740) but it was positively significant correlation at 5% level for ( $r_p$ ) with number of main branches and highly positively significant correlation with days taken for edible maturity (0.813), length of ovary before anthesis before anthesis (0.673) and seed weight of edible fruit (0.718). But number of seeds per fruit had negatively significant correlation at 5% level for ( $r_g$ ) and ( $r_p$ ) with leaf lobe number. The seed weight of edible fruit exhibited positively significant

correlation at 1% level for ( $r_g$ ) with days taken for edible maturity (0.745), length of ovary before anthesis before anthesis (0.831) and at 5% level with number of main branches (0.612). In phenotypic correlation the seed weight of edible fruit significantly positively correlated at 1% level with days taken for edible maturity (0.707) and length of ovary before anthesis before anthesis (0.805) and it was negatively correlated with leaf area, leaf lobe number. Length of ovary before anthesis had highly significant correlation at 1% level for ( $r_g$ ) with days taken for edible maturity (0.751) and plant height (0.674) and at 5% level with number of main branches (0.640). For ( $r_p$ ) ovary length had highly significant correlation at 1% level with days taken for edible maturity (0.714) and at 5% level with plant height (0.658). Length of ovary before anthesis negatively correlated with leaf lobe number and leaf area both phenotypically and genotypically. Leaf lobe number showed negatively significant correlation at 5% level for ( $r_g$ ) with days taken for edible maturity (-0.563). Leaf area showed negatively correlated with days taken for edible maturity for ( $r_g$ ) and ( $r_p$ ). Leaf lobe number exhibited negative and significant correlation with days taken for edible maturity (-0.563) for ( $r_g$ ) and also showed negative correlation with leaf area both for ( $r_g$ ) and ( $r_p$ ) and with day taken for edible maturity for ( $r_p$ ). Plant height showed no significant correlation with days taken for edible maturity, leaf area, leaf lobe number. Number of main branches also showed no significant correlation with days taken for edible maturity leaf lobe number, leaf area and plant height but all are positively correlated except leaf lobe number.

### **Path analysis of yield components**

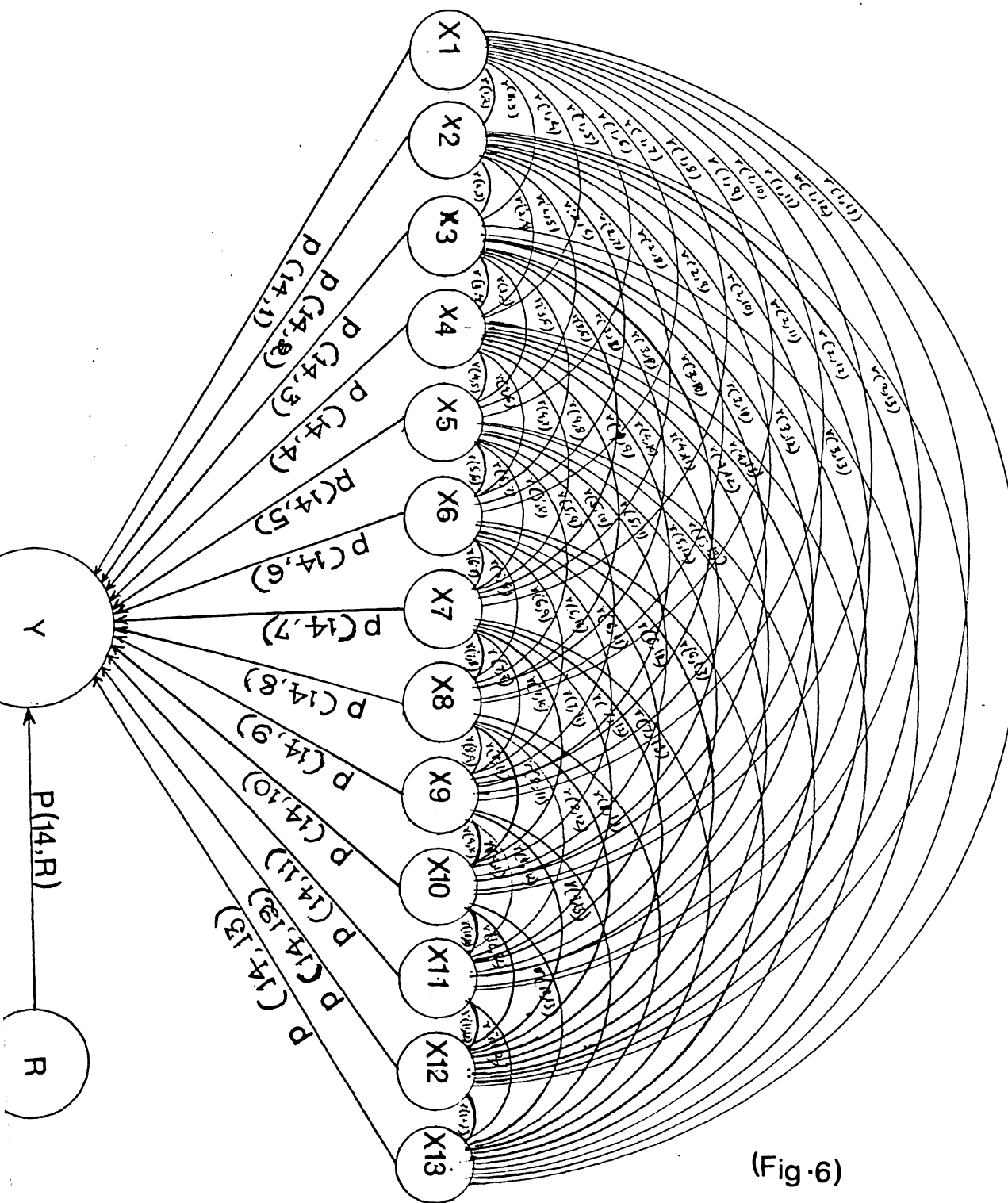
In order to find out the cause and effect relationship on yield per plant, path coefficient analysis was carried out taking 14 quantitative attributes in *Melothria heterophylla* (Lour) Cogn.. The correlation of yield per plant with other characters were partitioned into components of direct and indirect effects that could reflect the nature of these associations and relative importance of the components in determining yield. The genotypic correlation coefficients were used in path analysis and the results was presented in Table-8.

**Table-8. Genotypic correlation coefficient of different characters of *Melothria heterophylla* (Lour) Cogn.**

Character	Days taken for edible maturity	Leaf area (cm <sup>2</sup> )	Leaf lobe No.	Plant height (cm)	No. of main branches	Inter-nodal length (cm)	Length of ovary (cm)	Seed wt. of edible fruit (gm)	No. of seed per fruit	Length of edible fruit (cm)	Girth of edible fruit (cm)	Wt. of edible fruit (gm)	No. of fruits per plant	Genotypic correlation coefficient with yield/plant (Kg)
1	<u>-0.093</u>	-0.007	-0.013	-0.024	-0.024	-0.013	-0.120	-0.022	-0.021	0.030	-0.042	1.059	0.074	0.827**
2	0.027	<u>0.026</u>	-0.004	-0.018	-0.017	0.046	0.029	-0.001	0.005	-0.008	-0.048	-0.189	-0.091	-0.245
3	0.052	-0.005	<u>0.022</u>	-0.018	-0.022	0.007	0.049	-0.014	0.014	-0.016	0.043	-0.678	0.046	-0.439
4	-0.035	0.007	-0.006	<u>-0.065</u>	-0.026	0.016	-0.108	0.011	-0.009	0.012	-0.011	0.604	0.006	0.396
5	-0.039	0.008	-0.009	-0.030	<u>-0.057</u>	0.017	-0.102	0.018	-0.017	0.018	-0.052	0.801	0.047	0.603*
6	0.012	0.012	-0.002	-0.010	-0.010	<u>0.101</u>	-0.016	0.006	-0.003	-0.004	-0.027	-0.186	0.050	-0.068
7	-0.070	-0.005	-0.007	-0.044	-0.036	0.010	<u>-0.160</u>	0.025	-0.017	0.024	-0.056	1.047	0.068	0.780**
8	-0.069	-0.001	-0.011	-0.025	-0.035	0.021	-0.133	<u>0.033</u>	-0.018	0.025	-0.078	0.920	0.039	0.665**
9	-0.080	-0.005	-0.013	-0.024	-0.039	-0.013	-0.111	0.022	<u>-0.024</u>	-0.028	-0.032	1.011	0.087	0.805**
10	-0.085	-0.007	-0.011	-0.023	-0.031	-0.012	-0.117	0.022	-0.021	<u>0.033</u>	-0.020	0.944	0.062	0.733**
11	-0.023	-0.007	-0.006	-0.004	-0.017	0.016	-0.051	0.013	-0.005	0.004	<u>-0.174</u>	0.652	-0.137	0.276
12	-0.079	-0.004	-0.012	-0.031	-0.036	-0.015	-0.134	0.022	-0.020	0.025	-0.091	<u>1.251</u>	0.049	0.925
13	-0.024	-0.008	-0.004	-0.001	-0.009	0.018	-0.038	0.004	-0.008	0.007	-0.084	0.218	<u>0.282</u>	0.528

\* Significant at 1% level, \*\* Significant at 5% level.  
The residual effect = 0.0015. Underlined figures denotes direct effect.

H DIAGRAM FACTORS INFLUENCING YIELD IN  
Melothria heterophylla (Lour.) Cogn.



(Fig.6)

X<sub>1</sub> - Days taken for edible maturity; X<sub>2</sub> - Leaf area (cm<sup>2</sup>); X<sub>3</sub> - Leaf lobe No.; X<sub>4</sub> - Plant height (mt); X<sub>5</sub> - No. of main branches; X<sub>6</sub> - Inter nodal length (cm); X<sub>7</sub> - Length of ovary (cm); X<sub>8</sub> - Seed wt. of edible fruit (gm); X<sub>9</sub> - No. of seeds per fruit; X<sub>10</sub> - Length of edible fruit (cm); X<sub>11</sub> - Girth of edible fruit (cm); X<sub>12</sub> - Wt. of edible fruit (gm); X<sub>13</sub> - No. of fruits per plant; Y - Yield per plant (Kg); R - Residual.

The results obtained in path analysis revealed that weight of edible fruit (1.251) had the highest positive direct effect on yield per plant and was followed by number of fruits per plant (0.282), internodal length (0.101), seed weight of edible fruit (0.033), length of edible fruit (0.033), leaf area (0.026) and leaf lobe number (0.022). High negative direct effect were exhibited by girth of edible fruit (-0.174), followed by length of ovary before anthesis before anthesis (-0.101), days taken for edible maturity (-0.093), plant height (-0.065), number of main branches (-0.057), number of seeds per fruit (-0.24).

The indirect effects of length of ovary before anthesis via leaf area, leaf lobe number were in positive direction but, via days taken for edible maturity, plant height number of main branches, internodal length, seed weight of edible fruit, number of seeds per fruit, length of edible fruit, girth of edible fruit, weight of edible fruit, number of fruits per plants were found to bear negative effects thereby producing a high negative direct effect (-0.160).

Seed weight of edible fruit exhibited positive direct effect. The indirect effect of seed weight via days taken for edible maturity, leaf area, leaf lobe number were in negative direction, but rest of the characters were found to exert positive direction.

The indirect effect of number of seeds per fruit via leaf lobe number, leaf area, plant height, internodal length were in positive direction while via other characters were of negative direction.

The direct effect of length of edible fruit same as that of seed weight of edible fruit. The indirect effect of length of edible fruit except leaf area, leaf lobe number, internodal length, number seeds per fruit were in positive direction.

Girth of edible fruit showed high negative direct effect (-0.174). The indirect effects of girth of edible fruit via number of seeds per fruit, number of fruits per plant, leaf lobe number were in positive direction and rest were in negative direction.

The direct effect of weight of edible fruit was high and positive (1.251). The indirect effect of this character via days taken for edible maturity, plant height, number of main branches, length of ovary before anthesis, seed weight of edible fruit, number of seeds per fruit, length of edible fruit, girth of edible fruit, number of fruits per plant were having positive values, where as leaf area, leaf lobe number, internodal length were having negative values.

The direct effect of number of fruits per plant was also high and positive (0.282). The indirect effect of this character via leaf area and girth of edible fruit were in negative direction and rest were in positive direction.

The indirect effects of days taken for edible maturity via plant height, number of main branches length of ovary before anthesis, seed weight of edible fruit, number of seeds per fruit, length of edible fruit, girth of edible fruit, weight of edible fruit, number of fruits per plant were in negative direction and rest characters were in positive direction.

The indirect effect of leaf area via plant height, number of main branches, internodal length, girth of edible fruit were in positive direction and rest characters were in negative direction.

The indirect effect of leaf lobe number via internodal length and number of fruits per plant were having positive values and rest characters were having very low negative values.

The direct effect of plant height was negative value (-0.065). The indirect effect of plant height except leaf lobe number were in negative values.

The indirect effect of number of main branches via leaf lobe number were in positive direction and rest characters were in negative direction.

The direct effect of internodal length was high and positive (0.101). The indirect effect of internodal length via days taken for edible maturity, number of seeds per fruit, length of edible fruit, weight of edible fruit were in negative direction and rest of the characters were in positive direction.

## ultivariate analysis of genetic divergence

Simultaneous variation in all the characters of 15 genotypes were tested for assessing the nature of genetic divergence among them following  $D^2$  analysis and nonical analysis.

### $D^2$ analysis

The  $D^2$  estimates corresponding to 105 possible paired combinations among 15 genotypes were calculated and presented in Table -9. The  $D^2$  value obtained for a pair of population was taken as the calculated value of  $X^2$  and was tested against the tabulated value of  $X^2$  which clearly showed that all the  $D^2$  values were significant. Thus, it would be worth while to classify the population into different genetic groups on the basis of the aggregate effects of the characters studied.

The  $D^2$  values ranged from 400.08 between the genotypes BMH-10 and BMH-28 to 15933.14 between BMH-24 and BMH-31 indicating that most genotypes are quite close to each other genetically while others are strongly diversified. The genetic closeness between the genotypes BMH-10 and BMH-28 was apparently due to their similarities in characters such as length of ovary before anthesis, length of edible fruit, girth of edible fruit, weight of edible fruit, yield per plant (Table-3). On the other hand, the maximum distance between BMH-24 and BMH-31 could be attributed to large difference in days taken for edible maturity leaf area, leaf lobe number, plant height, internodal length, length of ovary before anthesis, seed weight of edible fruit, number of seeds per fruit, length of edible fruit, weight of edible fruit, yield per plant. Other divergent combinations were BMH-31 and BMH-12 ( $D^2 = 15897.27$ ), BMH-31 and BMH-21 ( $D^2 = 13460.62$ ), BMH-11 and BMH-34 ( $D^2 = 12144.14$ ) BMH-31 and BMH-19 ( $D^2 = 11395.71$ ), BMH-31 and BMH-15 ( $D^2 = 11136.91$ ), BMH-31 and BMH-13 ( $D^2 = 10035.82$ ), BMH-31 and BMH-27 ( $D^2 = 10001.06$ ) BMH-31 and BMH-8 ( $D^2 = 9344.28$ ), BMH-31 and BMH-35 ( $D^2 = 6028.20$ ), BMH-31 and BMH-16 ( $D^2 = 6054.49$ ) thus indicating BMH-31 as a genetically different entry.



Among genetically close combinations mentioned may be made of BMH-21 and BMH-19 ( $D^2 = 460.82$ ) and BMH-13 and BMH-34 ( $D^2 = 695.58$ ).

### Clustering pattern

Following Tocher's method, the 15 genotypes were grouped into two clusters (Table-10). The cluster I comprised all genotypes except BMH-31 which was included in cluster-II because of wide divergent present on BMH-31 which was suppressed the other types. So we went for sub clustering the large cluster i.e. cluster-I. By sub clustering, seven sub clusters were estimated (Table-11). The sub cluster I comprised of three genotypes namely BMH-10, BMH-28, BMH-35; while sub cluster II consisted of 2 genotypes such as BMH-19, BMH-21; sub cluster-III consisted 4 genotypes namely BMH-13, BMH-34, BMH-15, BMH-12, sub cluster-IV consisted 2 genotypes namely BMH-8, BMH-27.

**Table-10. Clustering pattern of fifteen *Melothria heterophylla* genotypes.**

Cluster No.	Number of genotypes included	Serial number of genotypes	Name of the genotypes
I	14	1, 2, 3, 4, 5	BMH-8, BMH-10, BMH-12
		6, 7, 8, 9	BMH-13, BMH-15, BMH-16
		10, 11, 12	BMH-19, BMH-21, BMH-24
		14, 15	BMH-26, BMH-27, BMH-28 BMH-34, BMH-35
II	1	13	BMH-31

**Table-11 Sub-clustering pattern of large cluster i.e. cluster – I.**

Cluster No.	Number of genotypes included	Serial number of genotypes	Name of the genotypes
I	3	2, 12, 15	BMH-10, BMH-28, BMH-35
II	2	7, 8	BMH-19, BMH-21
III	4	3, 4, 5, 14	BMH-12, BMH-13, BMH-15, BMH-34
IV	2	1, 11	BMH-8, BMH-27
V	1	6	BMH-16
VI	1	9	BMH-24
VII	1	10	BMH-26

### Intra-and Inter-cluster distance

From the average Intra and Inter-cluster distance presented in Table-12 & 13, it was evident that among the intra cluster distance between I and I was 18214.39. The average inter-cluster distance was 9812.15

**Table-12. Average intra (diagonal) and inter-cluster distance ( $D^2$  values) in 15 *Melothria heterophylla* (Lour) Cogn. genotypes.**

Cluster	I	II
I	18214.39	9812.15
II	--	--

**Table-13. Average intra - and inter- cluster distance ( $D$ ) = ( $D^2$ ) values in 15 *Melothria heterophylla* (Lour) Cogn. genotypes.**

Cluster	I	II
I	134.96	99.06
II	--	--

The remaining three sub cluster V, VI, VII consisted of one genotypes each namely BMH-16, BMH-24, BMH-26, respectively.

### Intra- and Inter- sub cluster distance

From the Table-14 & 15, the average Intra- and Inter sub cluster distance, it was evident that among the two multi genotype sub clusters, sub cluster II had the minimum intra-sub cluster distance ( $D^2 = 230.41$ ). The average inter- sub cluster distance revealed that the most divergent sub clusters were VI and VII ( $D^2 = 8363.76$ ) followed by II and VI ( $D^2 = 7069.88$ ) and I and VI ( $D^2 = 5216.68$ ). The least diversified sub cluster were I and V ( $D^2 = 1351.67$ ) followed by I and VII ( $1357.62$ ) and I and IV ( $D^2 = 1570.64$ ).

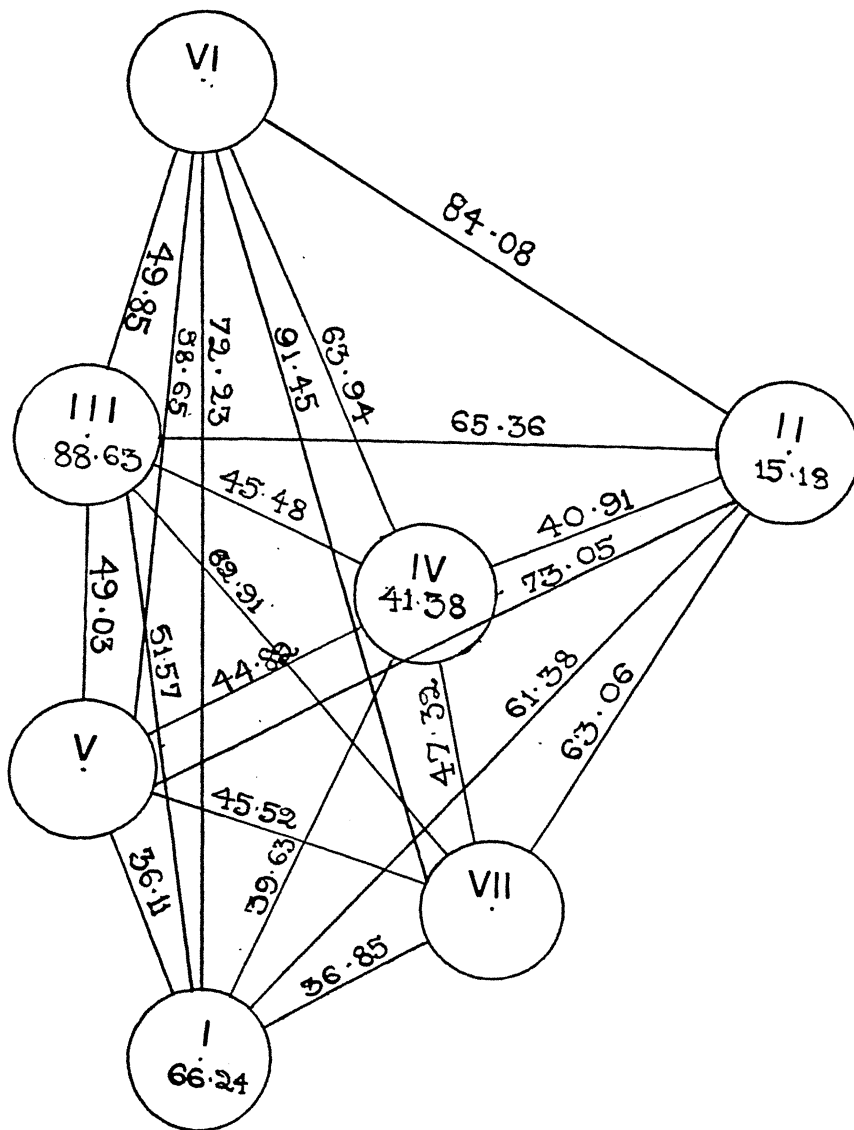
**Table-14. Average intra (diagonal) and inter-sub cluster distance ( $D^2$  value) of large cluster i.e cluster-I.**

Sub clusters	I	II	III	IV	V	VI	VII
I	4387.17	3767.48	2659.98	1570.64	1351.67	5216.68	1357.62
II		230.41	4271.32	1673.98	5335.68	7069.88	3976.03
III			7855.68	2068.06	2403.90	2484.62	3957.47
IV				3767.48	2009.00	4088.13	2239.57
V					--	3439.83	2072.44
VI						--	8363.76
VII							--

**Table-15. Average intra (diagonal) and inter-sub cluster distance ( $D$ ) = ( $\sqrt{D^2}$  value) of large cluster i.e cluster-I.**

Sub clusters	I	II	III	IV	V	VI	VII
I	62.24	61.38	51.57	39.63	36.77	72.23	36.85
II		15.18	65.36	40.91	73.05	84.08	63.06
III			88.63	45.48	49.03	49.85	62.91
IV				41.38	44.82	63.94	47.32
V					--	58.65	45.52
VI						--	91.45
VII							--

The genetical distance expressed as  $(D^2)^{1/2}$  among different sub clusters are depicted diagrammatically in Fig-7 which revealed that sub cluster II, III, V, VI and VII were more divergent from one another while sub cluster I, VII, IV, V were relatively less diversified. It was seen that sub cluster I was the closest to sub cluster V and vice versa. The sub cluster II was the nearest to sub cluster IV and vice versa; sub cluster III was the closest to sub cluster IV but not vice versa. The sub cluster VI was the nearest to sub cluster III but not versa. Sub cluster VII was the closest to sub cluster I but not vice versa. Thus it was apparent that the entries included in sub cluster I were having more close resemblance in character expression with that in sub cluster IV, V and VII.



(Fig-7)

Relative Disposition of Subclusters Showing Average Genetic Distance (D) Between And Within Them in

Melothria heterophylla (Lour.) Cogn.

### Characteristic features of the clusters and sub clusters

Table-16 shows cluster means of 14 quantitative characters in *Melothria heterophylla* (Lour) Cogn. cluster I consisting of 14 genotypes exhibited moderate expression for girth of edible fruit with cluster II and rest characters were totally diversified.

**Table-16. Cluster means of 14 quantitative characters in *Melothria heterophylla* (Lour) Cogn.**

Characters	I	II
Plant height (mt)	2.91	3.08
Number of main branches	5.45	6.67
Internodal length (cm)	9.49	13.64
Leaf area (cm <sup>2</sup> )	47.31	125.79
Leaf lobe number	2.20	1.00
Length of ovary (cm)	0.88	0.69
Days taken for edible maturity	10.21	7.67
Length of edible fruit (cm)	5.15	3.55
Girth of edible fruit (cm)	2.09	2.07
Number of seeds per fruit	39.76	27.67
Seed weight of edible fruit (gm)	3.28	2.74
Weight of edible fruit (gm)	15.66	8.16
Number of fruits per plant	120.19	106.67
Yield per plant (Kg)	2.96	0.87

Table-17 shows sub cluster means of 14 characters. Sub cluster-I consisting of 3 genotypes exhibited moderate expression for almost all characters except internodal length and number of fruits per plant which recorded maximum value.

**Table-17. Sub cluster means of 14 quantitative characters in *Melothria heterophylla* (Lour) Cogn.**

Characters	I	II	III	IV	V	VI	VII
Plant height (mt)	3.00	2.32	2.74	3.02	4.08	4.05	2.32
Number of main branches	6.22	3.00	6.25	4.33	5.33	7.33	5.33
Internodal length (cm)	12.01	7.07	8.21	9.85	11.04	7.41	11.70
Leaf area (cm <sup>2</sup> )	49.40	35.56	43.96	41.44	69.58	52.30	62.44
Leaf lobe number	2.89	3.00	1.25	3.17	2.33	3.67	1.00
Length of ovary (cm)	0.92	0.62	1.20	0.87	1.01	1.13	0.87
Days taken for edible maturity	9.78	7.17	11.75	10.34	10.00	12.33	9.33
Length of edible fruit (cm)	5.11	3.28	6.42	4.03	4.92	7.42	4.08
Girth of edible fruit (cm)	1.97	1.93	2.14	2.11	2.23	2.08	2.44
Number of seeds per fruit	41.78	22.83	49.34	35.67	34.00	50.33	32.67
Seed weight of edible fruit (gm)	3.53	1.59	3.81	3.03	3.32	4.25	3.24
Weight of edible fruit (gm)	13.96	6.60	19.32	14.83	20.22	21.13	15.82
Number of fruits per plant	135.11	109.84	123.75	118.34	118.00	98.67	109.33
Yield per plant (Kg)	1.92	0.73	2.42	1.75	2.39	2.06	1.73

Sub cluster II having 2 genotypes was characterised by its lowest days taken for edible maturity, length of ovary before anthesis, seed weight of edible fruit, number of seeds per fruit, length of edible fruit, weight of edible fruit, girth of edible fruit and yield per plant.

Sub cluster III having 4 genotypes was characterised by highest length of ovary before anthesis.

Sub cluster IV having 2 genotypes exhibited second highest leaf lobe number next to sub cluster VI.

Sub cluster V, a single genotype sub cluster was characterised for its highest leaf area, plant height.

Sub cluster VI, also a single genotype sub cluster exhibited highest values for characters like days taken for edible maturity, leaf lobe number, number of main branches, internodal length, seed weight of edible fruit, number of seeds per fruit, length of edible fruit, weight of edible fruit and lowest number of fruits per plant.

Sub cluster VII a monogenotypic sub cluster, exhibited lowest leaf lobe number.

### **Relative contribution of characters to divergence**

An analysis of relative contribution of characters to divergence has been presented in Table-18. Rank total over the paired combinations were also used as an additional criterion for assessing the relative contribution of the characters. On the basis of average  $D^2$  values for individual character over 105 paired combinations, it was found that girth of edible fruit contributed the maximum (21.28%) followed by number of fruits per plant (18.69%) and internodal length (10.50%). Rank totals indicated similar trend for the same characters in that order. Other characters of importance for divergence were leaf area, weight of edible fruit & number of seeds per fruit.

### **Canonical analysis**

From canonical analysis it was found that two canonical roots having 52.7 and 27.5% of variability accounted for 80.2% of total variability, thus qualifying for graphic representation. The values of the first two canonical vectors  $Z_1$ , and  $Z_2$  (Table-20) were used as co-ordinates in plotting a two dimensional dispersion of genotypic constellation in Fig-9. The grouping obtained through  $D^2$  analysis are super imposed on the constellation by canonical analysis. The scattered points on the  $Z_1$ - $Z_2$  graph were in good agreement with the magnitude of divergence measured by  $D^2$  statistics, thus very well corroborating the clustering and sub clustering by Tocher's method.

**Table-18. Average  $D^2$  values, percentage to total  $D^2$  and rank total of different characters studied in *Melothria heterophylla* (Lour) Cogn.**

Characters	Average $D^2$ Value	Percentage of total $D^2$	Rank Total
Plant height (mt)	162.04	4.37	805
Number of main branches	86.63	2.34	967
Internodal length (cm)	389.57 (III)	10.50 (III)	610 (III)
Leaf area (cm <sup>2</sup> )	354.06	9.54	733
Leaf lobe number	64.02	1.73	1008
Length of ovary (cm)	109.56	2.95	932
Days taken for edible maturity	34.29	0.92	1168
Length of edible fruit (cm)	304.33	8.20	628
Girth of edible fruit (cm)	789.45 (I)	21.28 (I)	456 (I)
Number of seeds per fruit	153.69	4.14	836
Seed weight of edible fruit (gm)	185.13	4.99	776
Weight of edible fruit (gm)	305.91	8.25	638
Number of fruits per plant	193.25 (II)	18.69 (II)	486 (II)
Yield per plant (Kg)	77.74	2.10	982
TOTAL	3709.67		

The relative importance of the characters contributing towards divergence is reflected in the coefficients of the two canonical vectors ( $Z_1$  and  $Z_2$ ) presented in Table-19. From  $Z_1$  it is found that the important characters responsible for genetic divergence were girth of the edible fruit (0.6043), number of fruits per plant (0.4395), internodal length (0.4081) and leaf area (0.3108). In second axis of differentiation, number of fruits per plant (0.4962), length of the edible fruit (0.4810) and seed weight of edible fruit (0.3711) were found important. Thus the results of component analysis further corroborated the character contribution assessed by  $D^2$  and rank total.

**Table-19.** Estimates of the coefficient of the first two canonical vectors ( $Z_1$  and  $Z_2$ ) for 14 characters of 15 *Melothria heterophylla* (Lour) Cogn. genotypes.

Characters	Coefficient of the first two canonical vectors	
	$Z_1$	$Z_2$
Plant height (mt)	0.0313	0.2804
Number of main branches	-0.1420	-0.0947
Internodal length (cm)	0.4081	0.0610
Leaf area (cm <sup>2</sup> )	0.3108	0.2674
Leaf lobe number	0.1029	-0.1100
Length of ovary (cm)	-0.1705	0.1590
Days taken for edible maturity	-0.0741	0.1251
Length of edible fruit (cm)	-0.0947	0.4810
Girth of edible fruit (cm)	0.6043	-0.2217
Number of seeds per fruit	-0.2261	0.1421
Seed weight of edible fruit (gm)	-0.0724	0.3711
Weight of edible fruit (gm)	-0.2140	0.2634
Number of fruits per plant	0.4395	0.4962
Yield per plant (Kg)	-0.0330	0.1737
Variation accounted for in percent	$\lambda_1 = 52.7$	$\lambda_2 = 27.5$

**Table-20.** Mean values of first two canonical genotypes in *Melothria heterophylla* (Lour) Cogn.

Genotypes	Z <sub>1</sub>	Z <sub>2</sub>
BMH - 8	77.96	115.23
BMH - 10	102.03	126.92
BMH - 12	44.93	134.61
BMH - 13	73.84	145.45
BMH - 15	66.36	137.45
BMH - 16	97.19	145.56
BMH - 19	79.04	85.97
BMH - 21	77.14	74.10
BMH - 24	44.47	154.74
BMH - 26	118.58	115.61
BMH - 27	84.80	105.81
BMH - 28	111.23	122.16
BMH - 31	168.85	142.91
BMH - 34	63.03	133.01
BMH - 35	96.46	136.05

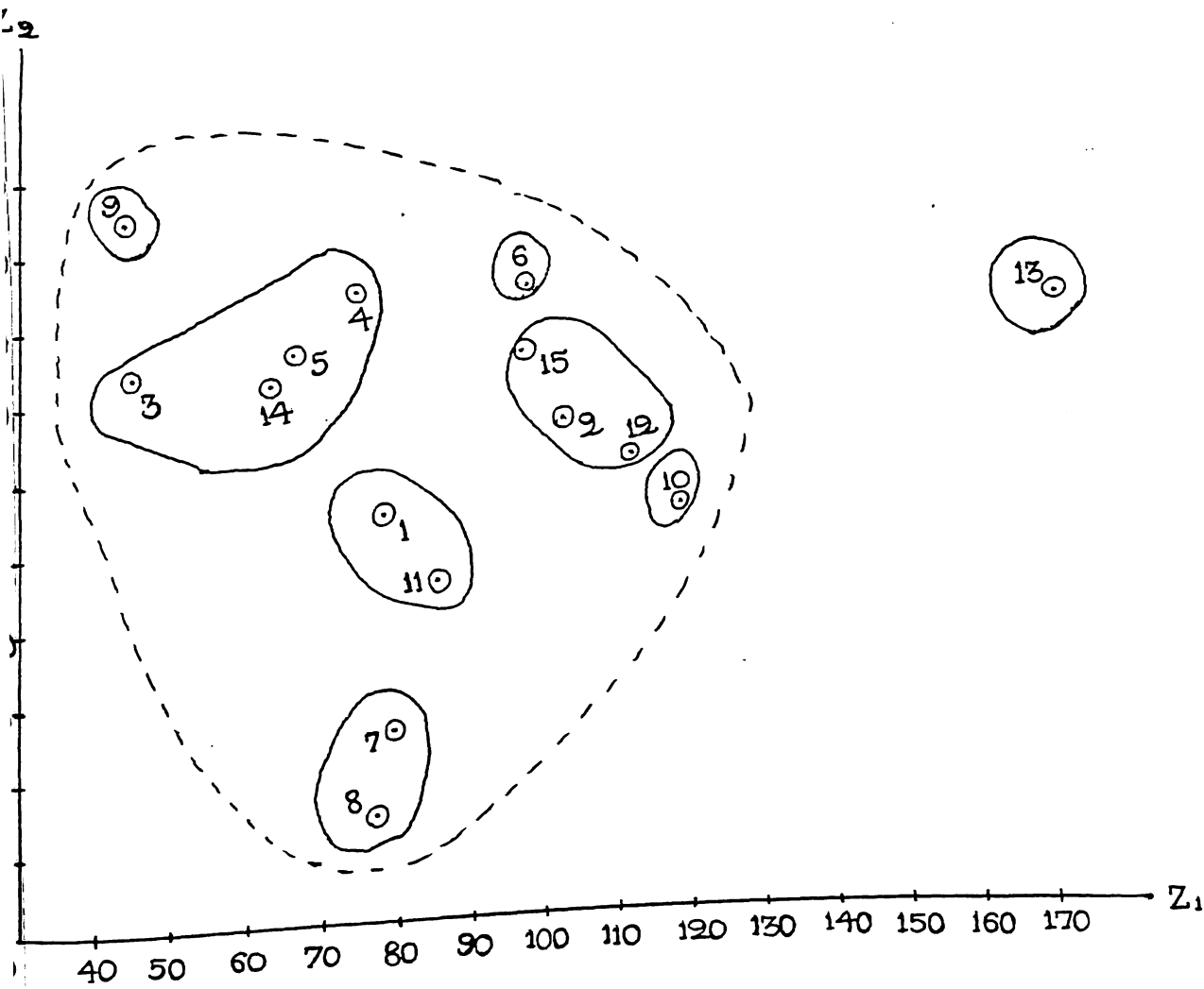


Fig.7 Group constellations in the  $Z_1$  and  $Z_2$  graph.

CHAPTER - V

Discussion

## DISCUSSION

The effectiveness of any plant breeding programme involving selection and hybridization, depends on the existence of genetic variability in the material and the extent to which it is heritable. Therefore, an assessment of the nature and magnitude of variability is one of the basic principles towards the successful breeding programme. The experimental findings of the above studies presented in foregoing chapter have shown some outstanding results which are being discussed here after.

### **Pattern of variation in plant attributes**

The most important economic character in the crop plants is the yield. Other supporting characters influencing yield and yield itself are governed by polygenes which are quantitatively inherited (Hayes, Immer and Smith, 1955). As the selection is based on the phenotypic observations, their reflection on genotypic value may not hold good unless observations on the quantitative traits are subjected and interpreted according to statistical procedures, since yield is much influenced by the environmental factors. Therefore, the genetic parameters like mean, range and variances etc. for different attributes in *Melothria heterophylla* (Lour) Cogn. have been computed to draw valid inference from the genotypes studied in the present investigations.

On examining the ANOVA (Table-3), the nature and magnitude of variability for 14 different characters can be understood. The values indicate highly significant differences for all the characters under study, thereby suggesting existence of large amount of variation in the material. So there is a scope for considerable improvement in this crop through the characters studied such as days taken for edible maturity, leaf area, leaf lobe number, plant height, number of main branches, internodal length, length of ovary before anthesis, seed weight of edible fruit number of seeds per fruit, length of edible fruit, girth of edible fruit, weight of edible fruit, number of fruits per plant, yield per plant.

For understanding the breeding principles, two aspects are most important i.e., (i) selection can not creat variability but act only on that which is already in existence, (ii) selection can act effectively only on heritable differences (Allard, 1960). Thus, the first and foremost necessity for selection is to ascertain whether genetic variability for these characters is present in the population at significant level or not.

Further, the phenotypic mean values as the basis of comparison may fall far short of requirement and may even be misleading as the phenotypic effect sometimes influenced by environment thereby may not necessarily represent the genotypic values. To avoid this misleading information for correct interpretation of data on a sound genetic principle, statistics such as variance and co-efficient of variation etc. are to be computed for proper evaluation. The estimates of genetic parameters such as phenotypic and genotypic variances computed as per the methods suggested by Burton and Devance (1953), along with the co-efficient of variation permit a sound basis to determine the variability components so also to know the relative amount of heritable and non heritable variation for each of these characters.

From the investigations, it is clearly observed that there exists a wide range of phenotypic variation indicating large phenotypic variability for the fourteen quantitative characters. Further, genotypic variances calculated by deducting the environmental variances from their respective phenotypic variances also indicated higher values for these traits under study. The existence of large GV in a character indicates that major portion of it is attributed through its additive components and additive interaction in stead of dominance and epistatic components and usually favours an effective selection. In comparing the PCV and GCV values (Table-5), it is revealed that in general, the former values are greater than the latter in respect of all quantitative characters under study and the differences between the two with regards to their respective values are quite less indicating thereby a negligible influence of environment on such characters. (Chaudhury *et al.* 1973). The characters like leaf lobe number, leaf area, yield per plant & weight of edible fruit exhibited both high PCV and GCV values. Further, PCV exhibits parallelism effect with the GCV indicating that the phenotypes truly represent the genotypes.

In the present investigation, leaf lobe number, leaf area, yield per plant, weight of edible fruit, number of main branches, seed weight of edible fruit shown high GCV values indicating the presence of good amount of genetic variability in the material, so selection basing on these characters may be useful. Similar trend has been reported by Indires (1982) in bitter gourd. The rest of characters showing moderate to low GCV offer a little scope for selection.

The heritability is of interest to the plant breeder primarily as a measure of value of selection for a particular character in various types of progenies and as an index of transmissibility. Higher the heritability value of a character, less will be the environmental influence thereby indicating better opportunity for selecting a genetically good individual (Randhwa, *et al.* 1975). In the present study, high to very high heritability values have been obtained in all cases except number of main branches, girth of edible fruit. Since all except above two characters exhibit high to very high heritability percentage, it is presumed therefore that these characters might be highly heritable and less influenced by environment and selecting genotypes on the basis of such characters will be very fruitful. Singh *et al.* (1985) reported high heritability in pointed gourd in number of seeds per fruit, fruit length, fruit girth, yield per plant. High heritability for fruit number and fruit weight was also reported by Solani and Seth (1980) in cucumber. Weber and Moorthy (1952) suggested that informations concerning heritability of quantitative characters and their genetic and environmental variances when considered together might be useful for improving the efficiency of selection. Comparing the heritability estimates with the GCV values, it is seen that high values were obtained for weight of edible fruit, leaf area and yield per plant. So selection may be quite effective based on the characters like fruit weight and yield per plant. Similar results such as high GCV and high heritability values have been reported for yield per plant by Singh and Krishnaprasad (1989) in pointed gourd; for yield per plot and yield per hectare by Singh & Krishnaprasad (1989) in ridged gourd.

Though the study of heritability estimate is of importance, their scope is limited since they are estimated in broad sense and as they are prone to change with change in environment and the material. Further, the heritability estimate by itself may not be solely an useful index of genetic potentiality of a character. Thus heritability estimate along with genetic advance are more valuable than heritability value alone in predicting the response to selection. (Johnson *et al.* 1955; Robinson 1963). High heritability does not necessarily mean that the character will show high genetic advance (GA), but the case where above association exists, additive gene comes into prominence because no genetic advance is due to non-additive genes. The expected genetic advance from selection would indicate the genetic potentiality of the character under selection and also the effectiveness of

selection. The selection based on a character showing high genetic gain may be desirable particularly in the case of directional selection when the main aim of selection is to change the mean value of a character to have better standard. The result of the present study revealed high heritability and GA for the character such as leaf area, weight of edible fruit, number of seeds per fruit & number of fruits per plant, which may be resulted due to effect of additive genes (Panse, 1957; Liang and Walter, 1968) and may become amenable for selection. In other characters since low GA is associated with moderately high heritability, improvement may not be possible through selection based on these character because of non additive gene effects. Our findings are inconformity with the work of Singh *et al.* (1989), who have also found high heritability estimates and GA for fruit weight in pointed gourd. Further, high estimates of heritability and genetic advance for fruit weight has been reported by Prasad *et al.* (1988) in water mebn.

By taking a simultaneous studies of GCV, heritability estimates and GA at a glance, it is observed that in general, character with high GCV also had high GA as percentage of mean. Further, heritability when considered in conjunction with GCV and GA together, also exhibit a similar pattern with slight deviation. Thus selection based on the characters such as leaf area, weight of edible fruit, yield per plant will be effective for further improvement in *Melothria heterophylla* (Lour) Cogn.

### **Character Association**

In *Melothria heterophylla* (Lour) Cogn., fruit yield which is an important economic character, is the ultimate effect of interaction of several quantitative traits and is highly susceptible to change in environment. Hence selection based on yield alone may not be very sound criterion for effecting selection. Among various component characters, a few of which may be directly and positively correlated with yield often act as a useful indicator in selection. Therefore a sound knowledge of much associations among the various traits, particularly in relation to yield and other economic characters is valuable in planning successful and effective breeding programme. Hence correlation studies are helpful in choosing superior genotypes from their phenotypic expression (Robinson, 1966).

From the present study, it was found that the genotypic correlation coefficients exhibited higher values (Table-6 & 7) for most of the variable pairs than the phenotypic correlation coefficients suggesting that there was a strong inherent association between the various characters studied. Further, as the ( $r_g$ ) in parallel to the ( $r_p$ ) it may be assumed that there is not much influence of environment in determining the association of these yield attributing factors with yield and possibly this is due to a strong genetical make up of the plant. The strong positive association of character with yield may be attributed to linkage and pleiotropy as reported by Wigan and Mather (1942) and Sprague (1966).

Significant positive correlation both at genotypic and phenotypic level were observed for yield per plant with number of main branches, length of ovary, days taken for edible maturity, length of edible fruit, number of seeds per fruit, seed weight of edible fruit, weight of edible fruit. Result of similar trend were also reported by Indires (1982) in bitter melon, Prasad *et al.* (1988) in watermelon, Abusalecha and Dutta (1988) in cucumber. This association suggests that selection for these components will be effective in improving yield of *Melothria heterophylla* (Lour) Cogn.

Leaf lobe number showed significant and negative correlation with days taken for edible maturity. Length of ovary indicated significant and positive correlation with plant height, number of main branches, days taken for edible maturity which suggesting that with increase in these three components the ovary length can also increased. Further, its association with leaf area and leaf lobe number were negative thereby suggesting its least importance as a criterion for selection.

Seed weight of edible fruit exhibited significant and positive correlation with number of main branches, length of ovary before anthesis and days taken for edible maturity. So these three characters were given more importance for selection. The rest character such as leaf area, leaf lobe numbers were negative & the internodal length was positive but low value shows no importance.

Number of seeds per fruit exhibited significant and positively correlated with number of main branches, length of ovary before anthesis, days taken for edible maturity, seed weight of edible fruit but significant and negative correlation with leaf lobe number and only negatively correlated with leaf area, positively correlated with plant height. This suggested that more seeds can be obtained by increasing the main branches, ovary length before anthesis, more seed weight, more days for edible maturity and less leaf lobe number. Other characters suggest least importance for selection.

Length of edible fruit indicated positive and significant correlation with number of main branches, length of ovary before anthesis, days taken for edible maturity, seed weight of edible fruit & number of seeds per fruit which suggested that long fruit of *Melothria heterophylla* (Lour) Cogn. will have more number of seeds and more seed weight. The flower with long ovary, the plant with more main branches will produce long fruit. Further fruit length is negatively correlated with leaf area, leaf lobe number, internodal length which suggest it had least importance for selection.

Weight of edible fruit exhibited significant and positive correlation with number of main branches, length of ovary before anthesis, number of seeds per fruit, seed weight of edible fruit, days taken for edible maturity, length of edible fruit but negatively and significantly correlated with leaf lobe number and only positive correlation with girth of edible fruit. Thus fruit having more length more seeds per fruit, more seed weight, long ovary, more days taken for edible maturity will have higher individual fruit weight having higher fruit girth. The leaf having less lobe number produce more fruit weight.

Number of fruits per plant showed positive correlation in all case except leaf area and fruit girth where it was negatively correlated which suggested that fruit number per plant can be increased by lowering the leaf area and fruit girth.

From the above discussion, it can be concluded that simultaneous improvement of fruit yield and fruit weight, fruit yield and fruit length, fruit yield and seed weight of edible fruit, fruit yield and number of seeds per fruit, fruit yield and ovary length before anthesis, fruit yield and number of main branches, fruit yield and days taken for edible maturity can be made if selection made for yield. Therefore selection based on these characters in *Melothria heterophylla* (Lour) Cogn. will enable to isolate superior genotypes.

## Direct and indirect effect of characters on plant yield

Correlation co-efficient which measures the association between two characters may not give true or comprehensive picture of a rather complex situation due to mutual relationship among different characters which may be positive or negative. In such situation, path coefficient analysis devised by Wright, 1921 furnish a means of measuring direct and indirect effects of each individual variable through the other variables on the end product (yield).

The cause and effect relationship with values of correlation and path co-efficient for the components of yield at genotypic level is shown in Fig-7 and their direct and indirect effects in Table-8. The results obtained in the present investigation revealed that weight of edible fruit, number of fruits per plant, internodal length, seed weight of edible fruit, length of edible fruit had maximum direct positive effect on yield. Further girth of edible fruit, length of ovary before anthesis, days taken for edible maturity, plant height, number of main branches had maximum negative direct effect on yield. Highest direct effect of days to first harvest, average weight of fruit, number of fruits per plant on yield of bottle gourd was reported by Rajnarayan *et al.* (1996). Rana *et al.* (1985) reported fruit weight exhibited positive direct effect on yield of pumpkin and same opinion given by Zhang and Wang, 1980 in watermelon.

In the present study, fruit weight though exhibited highest significant positive correlation with yield at genotypic level showed also highest positive direct effect on yield due to their indirect effect via characters such as days taken for edible maturity, length of edible fruit, number of seeds per fruit, seed weight of edible fruit, number of main branches, girth of edible fruit, plant height, number of fruits per plant. The number of fruits per plant indicated a second highest positive direct effect on yield but insignificant positive correlation with yield.

On the basis of our findings, it can be concluded that fruit weight, number of fruits per plant, internodal length, seed weight of edible fruit, length of edible fruit had considerable direct contribution to yield in *Melothria heterophylla* (Lour) Cogn. High

predicted improvement can be achieved by selecting a cultivars on the basis of above quantitative characters. Other characters which had shown significant correlation with yield is mainly due to indirect effect via these characters.

### **Genetic Divergence**

The multi variate analysis based on Mahalanobis  $D^2$  statistics is being employed as a powerful tool for measuring genetic divergence among the test genotypes (Sachan and Sharma, 1970; Mehndiratta and Singh, 1971; Mital *et al.*, 1975; Peter and Rai, 1976; Singh and Singh, 1976; Nair and Gupta, 1977). Published reports of Murty and Arunachalam (1966), Anand and Murty (1968), Ramanujam *et al.* (1974) have emphasised the merit of  $D^2$ -statistics and canonical analysis for genetic grouping of germplasm.

Being a numerical estimate, the multivariate technique has the added advantage over other criteria of permitting precise comparisons among all possible pairs of population in any given group. Since the estimates are obtained from a study of potential parents themselves, the required information is available before deciding parents for future recombination breeding thus can be used with advantage.

Hybrid derivatives from divergent parents are found to be promising probably because of complementary interaction of divergent genes in the parents. The present study revealed that BMH-13 and BMH-16, BMH-24, BMH-26 are the four most genetically divergent genotypes and selected these four as a female lines for breeding programme could be results oriented. These four genotypes are expected to produce heterotic hybrids and wide variation in segregating generations favouring selection of superior progeny when used as a female parents.

It was also observed that the characters like girth of edible fruit, number of fruits per plant and internodal length had contributed predominantly to divergence. Hence, selection of parents differing in those traits may be useful for the utilization of these parents as a female lines for breeding programmes in *Melothria heterophylla* (Lour) Cogn.

CHAPTER - VI

*Summary and Conclusion*

## SUMMARY AND CONCLUSION

During the course of present study as discussed earlier, the yield components of *Melothria heterophylla* (Lour) Cogn. were studied to workout the breeding programme and to formulate a suitable selection programme for improvement of this crop. The various aspects of 14 quantitative characters under yield components were evaluated in above collection of 15 genotypes to study the nature of variability and interrelationship of characters related to productivity among themselves through correlation studies. Further, the cause and effect relationship was carried out to determine the direct and indirect contribution of various traits to the most economic character, yield, through path analysis. In addition to the above, attempt was also made to assess genetic divergence among the genotypes through D<sup>2</sup>-statistics. The results of these investigations are summarised below.

1. A wide range of variation was noticed for almost all the characters as revealed through statistics of mean, range and co-efficient of variation. Further, analysis of variances indicated that 15 genotypes of *Melothria heterophylla* (Lour) Cogn. under study differed significantly among themselves for all the 14 quantitative characters studied.
2. The genetic parameters such as estimate of genotypic and phenotypic coefficients of variation indicated that for all the characters, the phenotypes represented true to genotypes. The characters like leaf lobe number, leaf area, yield per plant, weight of edible fruit, number of main branches exhibited wide range of genotypic coefficient of variation where as seed weight of edible fruit, length of edible fruit, internodal length plant height showed moderate GCV. The rest of traits exhibited low values for this parameter.

Moderate to very high heritability estimates were obtained for most of the character under study. Very high heritability was noticed (> 95%) for weight of edible fruit, plant height, seed weight of edible fruit, length of ovary before anthesis, leaf lobe number, number of seed per fruit. High heritability (90% < h<sup>2</sup> < 95%) was noticed for days taken for edible maturity, number of fruits per plant. Girth of edible fruit, number of main branches have moderate heritability.

4. Leaf lobe number exhibited highest genetic advance in percentage of mean and closely followed by leaf area, yield per plant, weight of edible fruit in descending order. Low genetic advance was noticed for girth of edible fruit, number of fruits per plant, length of ovary before anthesis, days taken for edible maturity, plant height and number of main branches. Rest character showed moderate values for this parameter.
5. Considering heritability estimate and GA together for effecting selection, the characters like weight of edible fruit, leaf area and yield per plant can be considered, since they are showing higher values for both the parameters.
6. Further, reviewing all the genetic parameters such as GCV, heritability estimate and GA all together at a glance, it may be stated that weight of edible fruit, leaf area, leaf lobe number and yield per plant may prove as effective criteria for selection.
7. Genotypic and phenotypic correlation co-efficient among the various quantitative characters indicated that yield per plant was positively and significantly correlated with weight of edible fruit, days taken for edible maturity, number of seeds per fruit, length of ovary, length of edible fruit, seed weight of edible fruit, number of main branches. Weight of edible fruit has exhibited positive & significant correlation with length of ovary before anthesis, number of seeds per fruit, length of edible fruit, seed weight of edible fruit, days taken for edible maturity, number of main branches and significant negatively correlated with leaf lobe number. Length of edible fruit has exhibited positive and significant correlation with days taken for edible maturity, number of seeds per fruit, seed weight of edible maturity, length of ovary before anthesis and number of main branches. Number of seeds per fruit has exhibited positive and significant correlation with days taken for edible maturity, seed weight of edible fruit, length of ovary before anthesis, number of main branches and significant negatively correlated with leaf lobe number. Seed weight of edible fruit has exhibited significant and positive correlation with length of ovary before anthesis, days taken for edible maturity, number main branches. Length of ovary has exhibited positive and significant correlation with days taken for edible maturity, plant height and number of main branches. Leaf lobe number has showed negative and significant correlation with days taken for edible maturity. Further genotypic correlation showed an effect of parallelism with phenotypic correlation thereby indicating the phenotypic association truly representing the genotypic association.

Path coefficient analysis of various quantitative characters indicated that weight of edible fruit, number of seeds per fruit, internodal length, seed weight of edible fruit, length of edible fruit, leaf area and leaf number had the maximum positive direct effect on yield of *Melothria heterophylla* (Lour) Cogn. The character viz. days taken for edible maturity, internodal length, length of ovary before anthesis, number of seeds per fruit have positive, significant and genotypic association with yield, exhibited negative direct effect due to the influence of indirect effects of aforesaid variables.

By using  $D^2$ -statistics and Tocher's method, the 15 genotypes were grouped into two clusters and the large clusters into seven sub clusters. The cluster-II was monogenotypic and also the sub cluster V, VI, VII were monogenotypic. The sub cluster I, II, III, IV consisted three, two, four genotypes respectively. The cluster-II was most divergent cluster and also sub cluster V, VI, VII were divergent sub clusters. The characters contributing more towards the genetic divergence were girth of edible fruit, number of fruits per plant and internodal length. The grouping by Tocher's method showed close correspondence with the didimensional dispersion of the genotypes by the first two canonical variates.

## CONCLUSION

From the findings of the present investigation, it may be concluded that besides direct selection for yield, indirect selection through edible fruit weight, number of seeds per fruit, length of edible fruit should be considered for the further improvement of yield in *Melothria heterophylla* (Lour) Cogn. The number of fruit per plant, internodal length, girth of fruit have also considerable direct effect on yield.

The most divergent genotype were BMH-31, BMH-16, BMH-24, BMH-26 might be selected as female parent for hybridization to produce highly heterotic hybrids and thus would produce wide spectrum of variation in the segregating generations.

For the present BMH-12 can be multiplied through stem cuttings for commercial cultivars of this crop owing to its high fruit weight highest yield and attractive colour.

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