VARIABILITY STUDIES IN WATERMELON
(*Citrullus lanatus* (Thunb) Mansf.)

By

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DECLARATION

I hereby declare that this thesis entitled "Variability studies in watermelon (*Citrullus lanatus* (Thunb) Mansf.)" is a *bonafide* record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship, or other similar title, of any other University or Society.

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CERTIFICATE

Certified that the thesis, entitled "Variability studies in watermelon (*Citrullus lanatus* (Thunb) Mansf.)" is a record of research work done independently by **Sri.V.N. Shibukumar** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship, or associateship to him.

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INTRODUCTION

INTRODUCTION

Watermelon (*Citrullus lanatus* (Thunb) Mansf.) is a tropical cucurbitaceous vegetable widely grown in India. The mature fruits are with attractive colour, sweet taste and refreshing effects. The fruits are also a good source of vitamin C, sugar and minerals (Bose and Som, 1986).

Watermelon is studied systematically and exploited in depth in USA (Hedrick, 1972), North India and West India (Seshadri, 1986). This is the one and only dessert vegetable crop of Kerala. Though the demand for this fruit is very high in Kerala during the summer months, its cultivation is seen limited in district viz. Malappuram, Kozhikodu, Kannur and Kasargod. Though the conditions are favourable for its cultivation throughout the state, we always depend on the neighbouring states for meeting our requirement and, practically very little research work has been done on this crop in Kerala. An exploratory trials conducted in Southern part of Kerala revealed that watermelon can be cultivated successfully [KAU, 1993(ii)].

The aim of any crop improvement programme is to evolve superior genotypes with high yield, increased quality and resistance to pests and diseases. The success of a crop improvement programme depends on the extent of genetic variability available in a breeding population. Yield, an extremely complex character is the result of many growth functions of a plant. An estimate of inter-relationship of yield with other traits is of immense help to a breeder. Correlation studies would facilitate effective selection for simultaneous improvement of one or many yield contributing components. Apart from the variability and correlation studies, the coefficient of variations, heritability, genetic advance, path analysis and discriminent function analysis will help in determining the extent of improvement that could be made in yield contributing characters.

With this view in mind the present investigation was carried out at College of Agriculture, Vellayani to assess the variability available in watermelon with respect to growth, yield and quality parameters. The study also aimed in identifying the superior genotypes based on systematic genetic evaluation so as to popularise the same in the southern region of Kerala.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Watermelon is a tropical cucurbitaceous vegetable crop. This is the one and only dessert vegetable crop grown in Kerala. Though the demand for this fruit is high during the summer months, its cultivation is established only in districts viz. Malappuram, Calicut, Cannanore and Kasargod. Very little work has been done on this crop in Kerala condition. A review of the available informations on watermelon and related crops were made and the details are presented in the following sections.

2.1 History and origin

There is much evidence (De Candolle, 1882) that the watermelon, Citrullus vulgaris Schard, which includes cultivated watermelon (now renamed Citrullus lanatus (Thunb) Mansf.) (Thieret, 1963) is indigenous to tropical Africa. This crop has evidently been cultivated for centuries by the people bordering the Mediterranean Basin. (Whitaker and Davis, 1962).

Pangolo (1930, 1944, 1955) has made extensive studies of Asiatic watermelons. According to him watermelon is indigenous to India. But Whitaker and Davis (1962) suggested that India is the secondary centre of diversification of the genus Citrullus.

2.2 Taxonomy and ploidy

Watermelon belongs to the family Cucurbitaceae sub family Cucurbitae and genus Citrullus. This genus consists of four species viz. Citrullus vulgaris, which include cultivated watermelon, Citrullus lanatus (Thunb) Mansf. (Thieret, 1963), C. colocynthes L., C. ecirrhosus Cogn and C. noudinianus (Sond.) Hook (Cogniause and Harmes, 1924).

The species classification of Citrullus and their relationship have been studied in relation to cucurbitacin content by Rehm et al. (1957). He has opined that there is one group of closely related species, viz., C. vulgaris, C. colocynthes and C. ecirrhosus with cucurbitacin E as the main bitter principle and the other group of isolated species, viz., C. noudinianus with cucurbitacin B together with E and their derivatives.

Baily (1930) stated that vulgaris can be divided into vars. lanatus and citroides, the latter comprising the citron or preserving melon producing fruits with hard inedible flesh and greenish or tan seeds. Whitaker (1933) considered C. colocynthoides as the probable ancestor of watermelon.

According to Shimotsma (1963) the basic chromosome number n = 12 and 2x = 24. Though, both monoecious and andromonoecious sex forms were reported in watermelon (Seshadri, 1986).

2.3 Genetic variability

2.3.1 Watermelon

Takur and Nandpuri (1974) conducted variability studies with twenty five varieties of watermelon. Shipper was the highest yielding variety followed by 'Specialnumberone' and had the highest number of branches. 'Specialnumberone' matured earliest and had the highest number of fruits.

Vashistha et al. (1983) conducted a study on variability and heritability in watermelon. Yield and eight yield related characters were investigated in 14 Indian and exotic varieties. Ryugu, a Japanese variety was the earliest to flower and had the highest sugar content and more branches/plant. Tarbooj selection from India had the highest average fruit weight and gave the highest yield/plant.

Analysis of data on fruit yield/plant and eight related traits from seven parents and twenty one hybrids from a complete diallel cross revealed that all the characters expressed significant difference between them (Sidhu and Brar 1985).

Laltaprasad *et al*. (1988) evaluated nine germplasm lines for fourteen characters and found that the phenotypic and genotypic coefficients of variation were high for fruits/plant, average fruit weight, seeds/fruit, 100 seed weight and fruit yield/plant.

In a varietal trial with eight varieties for thirteen quantitative characters, Arka Jyothi and Sugar Baby were ranked as the best varieties for early production of female flowers on lower nodes, fruits/vine, yield/vine, female flowers/plant, sex ratio, rind thickness and TSS, (Singh and Singh, 1989).

A varietal trial conducted at USA revealed that the variety 'Mirage' had the highest yield and 'Sugarlee' had the highest TSS content (Bayhan *et al*., 1991).

Hegde *et al*. (1994) conducted varietal trial with six varieties and reported that the vine length varied from 3.20 to 4.00m. Number of branches/vine ranged from 4.0 to 6.2. Fruit diameter was in a range of 9.5 to 13.6 cm. Number of fruits/vine ranged from 1.5 to 2.8, fruit weight from 3.00 to 7.6 kg and the yield/ha from 16.35 to 36.75 tons. Yield was higher in MHW-5 (36.75 t/ha) followed by Arka Manik (35.71 t/ha) Analysis of variance revealed that the varieties were significantly different for all the characters.

Rajendran and Thamburaj (1994) reported that significant differences were obtained among the genotypes for the characters viz. vine length, days to first female flower production, sex ratio, fruit/vine, fruit weight, yield/vine, crop duration, seeds/fruit and 100 seed weight. The coefficients of phenotypic variation varied from 8.57% for crop duration to 88.34% for yield/vine. The highest genotypic coefficient of variation was observed for yield/vine (67.60%) followed by sex ratio (60.68%). The 100 seed weight, average fruit weight, number of seeds/fruit, sex ratio and yield/vine showed equal magnitude of genotypic and phenotypic coefficients of variation.

2.3.2 Muskmelon

Deol et al. (1981) reported that the vine length ranged from 76.90 to 209.30 cm and a GCV of 20.89%. Number of primary branches/plant was within a range of 5.70 to 11.70 and a low GCV of 13.33%. Days to first female flower production was within a range of 32.70 to 53.10 with low GCV of 11.76%. Days to first harvest showed a very low GCV of 5.50% and yield/plant showed a GCV of 25.20%. He also reported that number of fruits/plant ranged from 1.30 to 4.5 with a GCV of 37.69%. Flesh thickness ranged form 1.12 to 2.49 cm with a low GCV of 19.79%. TSS was within a range of 4.10 to 10.60 and a mean of 8.70% and a low GCV of 19.50%.

Swamy *et al*. (1985) reported that main vine length ranged between 50.00 and 279.00 cm with a high GCV of 24.39%. Number of primary branches/plant ranged between 2.80 and 8.30 and a low GCV value of 14.24%. They observed considerable variation among 45 genotypes for number of days to first harvest. It was within a range of 75 to 96 days with a low GCV of 5.50%. They also reported that the total yield/plant ranged between 349 and 3061 g and a GCV of 35.03%. Number of fruits/plant had a GCV of 26.19%. Flesh thickness showed a range of 9.0 to 29.1 mm with a GCV of 23.59%. They reported a TSS range of 4.7 to 15.3% with GCV of 23.75%.

Chacko (1992) observed significant difference among the genotypes for percentage of germination, number of days to first male/female/bisexual flower production, days to first harvest, yield/vine, volume of fruits, length of vine, number of branches and reaction towards pest and diseases. The percentage of germination, yield, and number of branches exhibited moderate to high value of GCV.

2.4 Correlation studies

2.4.1 Watermelon

Sachan and Tikka (1971) reported that yield was highly correlated with number of primary branches, number of days taken for the appearence of the first female flower, and average fruit weight.

Sidhu and Brar (1981) reported that yield/plant was significantly correlated with 100 seed weight and fruit weight. TSS (%) and number of seeds/kg of flesh showed negative correlation with yield .

Choudhary and Mandal (1987) opined that there was high positive correlation at the genotypic and phenotypic level between yield/plant and the characters viz. number of fruits and female flowers/plant, fruit length and fruit weight.

Among nine germplasm lines evaluated for fourteen characters, fruit yield was correlated with vine length (0.63) and vine girth (0.61). (Lalitaprasad et al., 1988).

Singh and Singh (1988) evaluated eleven diverse genotypes at Sabour. Yield/vine was correlated with number of fruits/vine (r = 0.95) and TSS (0.85). Yield was negatively correlated with rind thickness, fruit weight and number of days and node number for the appearance of the first female flower.

Rajendran and Thamburaj (1993) reported the inter association of various yield components at phenotypic and genotypic level. The average fruit weight had significant positive association with number of fruits/vine, flesh-seed ratio and number of seeds/fruit, the 'r' values are 0.693, 0.686 and 0.855 respectively. The number of fruits/vine had significant negative relationship with days to first female flower production (r = -0.378). Similar trend of association was also observed through phenotypic correlation coefficient. The number of days taken for producing first female flower had significant and positive genotypic association with flesh seed ratio (r = 0.440). The genotypic association between days taken for producing first female flower and other traits viz. number of seeds/fruit and harvest index were significant and negative (r = -0.476 to -0.600).

2.4.2 Muskmelon

Chonkar et al. (1979) reported that the length of the main vine had a positive association both phenotypically and genotypically with fruit weight and the yield was strongly and positively correlated phenotypically and genotypically with the weight of the fruit and the length of the main vine.

Deol et al. (1981) found a positive and highly significant correlation for vine length with the number of branches/plant. Yield/plant showed a highly significant positive correlation with weight/fruit; but negative with number of days to produce first female flower. They also reported that the number of fruits/plant showed non significant association with yield/plant, fruit weight, flesh thickness, TSS, vine length and number of branches/plant. It had a positive correlation with quality traits.

Swamy _et al_. (1985) observed that yield/plant was positively correlated with number of fruits, average fruit weight, number of nodes on the main vine, vine length, internodal length and number of primary branches.

Vijay (1987) reported that fruits/vine and fruit weight were positively correlated with yield/vine.

Significant positive correlation was observed between percentage of germination and yield/vine and also with number of fruits/vine (Chacko, 1992).

2.5 Heritability and genetic advance

2.5.1 Watermelon

Sachan and Tikka (1971) noticed that the average fruit weight, yield and sex ratio exhibited high heritability and genetic advance and could be improved through selection.

In an experiment, twenty varieties of watermelon were evaluated in Ludhiana. Heritability estimates were found high for all the characters except yield/plant, number of days to first harvest, and number of branches/plant. Expected genetic advance was high for number of seeds/kg of fruit. (Thakur and Nandpuri 1974).

Vashistha et al. (1983) conducted a study on yield/plant and eight yield attributing characters. Heritability estimates were reported high for all the characters except yield/plant.

Laltaprasad et al. (1988) evaluated nine germplasm lines for fourteen characters. All these characters showed high heritability and genetic advance and were recommended for considering as selection criteria.

Rajendran and Thamburaj (1994) conducted a study on the genetic variability in biometrical traits in watermelon and recorded highest heritability estimates of 89% for 100 seed weight, followed by 60% for average fruit weight, 59% for yield/vine and 58% for number of seeds/fruit. He also recorded highest estimate of genetic advance (106.57%) for yield/vine followed by sex ratio (87.56%), 100 seed weight (79.00%), average fruit weight (71.76%) and number of seeds/fruit (69.87%).

2.5.2 Muskmelon

Deol et al. (1981) reported high heritability for main vine length (70.64%) but genetic gain was low (36.24%). Number of primary branches/plant showed moderate heritability (50.59%) and low genetic gain (19.79%). Days to first harvest also showed moderate heritability (42.70%) and very low genetic gain (7.40%). High heritability (85.23%) and high genetic gain (77.39%) was recorded for number of fruits/plant. Average fruit weight recorded high heritability (78.87%) and moderate genetic gain (66.92%). They also reported high heritability (250.54%) and low genetic gain (35.48%) for TSS.

Kalloo et al. (1981) reported high heritability and high genetic advance for yield/plant under North Indian conditions. However Lippert and Hall (1982) reported a low heritability value of less than 13% for this character under glasshouse conditions in Europe. They also reported low heritability for TSS (16%).

Swamy et al. (1985) reported moderate heritability (55.6%) and low genetic advance (37.6%) for main vine length in muskmelon. Number of primary branches/plant recorded a very low heritability (18.0%) and low genetic advance (12.4%). Number of days to first harvest had moderate heritability of 47.4% with low genetic advance. They also reported high heritability (62.1%) and moderate genetic gain (56.7%) for average fruit weight and high heritability (64.3%) and low genetic advance (39.7%) for TSS.

Chacko (1992) reported high heritability in conjunction with high genetic advance for percentage of germination, yield/vine and vine length.

2.6 Path coefficient analysis

2.6.1 Watermelon

Sidhu and Brar (1981) conducted path coefficient analysis in yield and eight yield related characters of watermelon and observed that number of node to the first female flower production and flesh weight had high direct as well as indirect effect on yield.

Singh and Singh (1988) reported that number of fruits/vine and TSS had the highest direct effect on yield.

Rajendran and Thamburaj (1989) reported that, among the various yield components, the average fruit weight had exerted maximum direct influence (0.354) on the yield of fruits/vine. The direct effect of other yield components were of low magnitude. Regarding the indirect effects, the effects through number of fruits/vine, harvest index, number of seeds/fruit and leaf area index on 60th day were of higher intensity. The indirect effect through days for female flower production turned to be negative.

Pandita *et al*. (1990) reported that number of fruits and early yield/plant had the highest direct positive effect on yield/plant.

2.6.2 Other cucurbits

Vijay (1987) reported that number of fruits/vine and weight of individual fruit in muskmelon had strong direct positive effects on yield and recommended them as selection criteria.

Path coefficient analysis of eleven yield component characters in cucumber correlated with internodal length, number of female flower and days to maturity had a positive highly significant direct effect on fruit yield. (Solanki and Shah 1992).

Gopalakrishnan *et al*. (1980) conducted a path coefficient analysis in pumpkin and reported that, length of vine had maximum direct effect (1.46) on fruit yield/vine. The weight of the first mature fruit had negative direct effect on fruit yield/plant.

2.7 Discriminant function analysis

The literature about the discriminant function analysis in watermelon is scarce. However, the available literature of some other crop are presented below.

The utilization of appropriate multiple selection criteria based on selection indices was found to be more desirable for making improvement in yield of mustard since several economically important characters contributed to yield. (Singh and Singh, 1974).

Patra (1980) noticed that, in groundnut, selection based on three components, such as shelling percentage, number of mature pods/plant and number of immature pods/plant proved more effective than direct selection based on yield alone.

Venkitaswaran (1980) reported that for spreading varieties of groundnut, weight/seed was the most important character in the selection index. Total number of pod was important in spreading varieties and in bunch varieties, height of main axis, total leaf area and weight/seed were equally important.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The experiment was conducted in the garden of the College of Agriculture, Vellayani, during the summer season (January-April), 1995.

3.1 Materials

Twenty types of watermelon popular in India were used for the study. Special emphasis was given to include a number of locally adapted types of south India. These varieties were collected from various research stations as well as seed production centres throughout the country. The details of these collections and their sources are listed in Table 3.

3.2 Methods

The present study was carried out with the objectives of assessing the genetic variability of watermelon in relation to growth, yield and quality parameters and the suitability of the available watermelon cultivars to the southern zone of Kerala so as to identify superior types for further breeding programmes.

All the genotypes of watermelon were raised for selfing during the summer (January-April), 1994. These selfed seeds were used for further studies. The experiment was carried out in RBD replicated thrice. Pits of 60 cm diameter and 40 cm depth were taken at a spacing of 3x2 m. Sowing was done in such a way that in each replication there was a single row of four plants/genotype.

The cultural operations were adopted as suggested in the Package of Practices Recommendation of the Kerala Agricultural University [1993 (i)].

3.3 Observations

Two middle plants out of the four in each replication, were tagged for the purpose of recording observations on growth and flowering parameters whereas the yield and yield attributes were recorded from all the four plants. The details of the experimental observations are given below.

3.3.1 Germination parameters

Number of days for germination of seeds and percentage of germination were accounted.

3.3.2 Growth parameters

Length of vine, number of branches per vine and internodal length (recorded after the harvest by uprooting the plant).

3.3.3 Flowering parameters

The number of days for the appearance of the first male flower and the node at which it appeared were observed. Similarly, the appearance of the first female or bisexual flower and the node at which it appeared, were also recorded. The node number was counted starting from the first node at the base of the plant.

3.3.4 Yield parameters

Number of days taken to harvest the first fruit, branch and node at which the first fruit was produced, total number of fruits/plant and yield/plant were recorded.

3.3.5 Fruit characters

Shape of fruit, rind colour, rind thickness, flesh colour, flesh firmness, flesh thickness and TSS of the fruits were recorded.

3.3.6 Reaction towards major pests and diseases

Observations were made on the incidence of fruit flies (*Dacus cucurbitae* and *Dacus dorsalis*) and serpentine leaf miner. A scoring procedure on a low resistance high susceptibility scale ranging from 0-3 was adopted. The scoring procedure (with scale 0-3) was attempted to study the reaction of the major diseases viz., fusarium wilt (Fusarium oxysporum) and an unidentified virus.

3.4 Statistical analysis

The data recorded from the field and laboratory were subjected to the following analysis.

3.4.1 Variance co-variance analysis

Analysis of variance and co-variance was done to test whether there was any significant difference among the genotypes with respect to various characters under study and to estimate the components of variance and co-variance.

Table 3. List of watermelon collections and their sources

Sl.No.	Identity	Source
1.	PKM 1	College of Horticulture, Periyakulam
2.	Fuken	College of Horticulture, Trichur
3.	RW 187-2	College of Horticulture, Trichur
4.	HW 1	College of Horticulture, Trichur
5.	Trichur	College of Horticulture, Trichur
6.	Maharashtra watermelon 10	College of Horticulture, Trichur
7.	Edakkad	District Agrl. Farm, Thaliparampa
8.	Echarikkota	District Agrl. Farm, Thaliparampa
9.	Thaliparmpa	District Agrl. Farm, Thaliparampa
10.	Sugar Baby	I.A.R.I., New Delhi.
11.	Asahi Yamato	I.A.R.I., New Delhi.
12.	Arka Manik	I.I.H.R., Bangalore
13.	Banglore	I.I.H.R., Bangalore
14.	Kuttipuram	R.A.R.S., Pattambi
15.	Pallipuram	R.A.R.S., Pattambi
16.	Manglore light green	R.A.R.S., Pilicode
17.	Manglore dark green	R.A.R.S., Pilicode
18.	Kanhangad	R.A.R.S., Pilicode
19.	Kasargod	R.A.R.S., Pilicode
20.	Nileswar	R.A.R.S., Pilicode

Source	Deg. of freedom	Mean sum of square		Mean sum of products
		x1	x2	
Block	(r-1)	MSBX1	MSBX2	MSPBX1X2
Treatment	(V-1)	MSVX1	MSVX2	MSPVX1X2
Error	(r-1) (v-1)	MSEX1	MSEX2	MSPEX1X2
Total	(rv-1)			

Where r - Number of replications

v - Number of treatments
(Panse and Sukhatme, 1978)

The components of variance were estimated as follows.

Environmental variance $(\hat{\sigma}e^2) = \dfrac{MSE\ X_1}{r}$

Genotypic variance $(\hat{\sigma}g^2) = \dfrac{MSVXI-MSEX1}{r}$

Phenotypic variance $(\hat{\sigma}p^2) = \sigma g^2 + \sigma e^2$

The estimate of σp^2 and σg^2 was done as per the method suggested by Johnson _et al_ (1955).

Genotypic coefficient of variation, GCV $= \dfrac{\sigma g \times 100}{\bar{X}}$

Phenotypic coefficient of variation, PCV $= \dfrac{\sigma P \times 100}{\bar{X}}$

3.4.2 Heritability

Heritability (H^2) (broad sense) is the fraction of genotypic variance to the phenotypic variance expressed in percentage.

$$H^2 = \frac{\sigma g^2 \times 100}{\sigma p^2}$$

3.4.3 Genetic advance

The expected genetic advance (GA) under selection was computed as per the method given by Allard (1960) and expressed as percentage of mean values.

$$\hat{GA} = \frac{KH^2 \sigma P}{\bar{X}} \times 100$$

Where K is the selection differential and equal to 2.06 if 5% selection is adopted in large samples. Co-variance components were estimated as follows

$$\sigma gij = \frac{MSPV - MSPE}{r}$$

where MSPV - Mean sum of product for treatment

MSPE - Mean sum of product for error

r = No of replications

Error (Environmental) co-variance σeij is

$\hat{\sigma} eij$ = MSPE and

$\hat{\sigma} pij$ = $\sigma gij + \sigma eij$

Genotypic, environmental and phenotypic correlation coefficients were estimted as

$$rgij = \frac{\sigma gij}{\sigma gi \times \sigma gj}$$

$$r\ eij = \frac{\sigma eij}{\sigma ei \times \sigma ej}$$

$$r\ pij = \frac{\sigma pij}{\sigma pi + \sigma pj}$$

3.4. Path coefficient analysis

Path analysis was introduced by Wright (1921) to refer to a type of casual analysis. A path coefficient is a standardised regression coefficient and it gives the changes in the dependent variable for a given changes in the appropriate independent variable, with all the remaining variables controlled or held constant. A path coefficient Pi measures the proportion of the change in the dependent variable y for which the independent variable Xj is directly responsible, the sign of Pi indicates the sign of the direct casual relationship.

r (Xi, Xj) Pi measures the indirect effect of Xi via Xj on Y. Pi is estimated from the solution of the simulataneous system of equation.

$$R\ xx\ Pi = Rxy$$

where Rxx is the matrix of intercorrelation between variables Xi and Xj , i = j = 1, 2, ...K.

Pi is the vector of Path Coefficients and Rxy is the vector of correlation between independent and dependent variables. The residual is estimated as $\left[1 - \sum_{i=1}^{K} Pi \cdot r\ (Xi \cdot Y)\right]^{1/2}$

3.5 Selection index

Selection indices were worked out through the application of discriminant function proposed by Smith (1936). The character used for the construction of selection indices were weight of fruits/plant, number of fruits/plant, weight of individual fruit and TSS.

Let Pij and Gij be the variance/co-variance matrices of orders n x n.

A discriminant function

$I = b1\ x1 + b2\ x2 + \ldots\ldots + bn\ xn$

was constructed such that

$\underset{\sim}{Pij}\ \underline{b} = \underset{\sim}{Gij}\ \underline{a}$

where $\underline{b}$ is the vector of coefficients in I and $\underline{a}$ is the vector of economic weights assigned to the genotypic values of individual characters and

$$\hat{\underline{b}} = \underset{\sim}{Pij}^{-1}\ \underset{\sim}{Gij}\ \underline{a}$$

Here it is assumed that all the characters are economically equally important ie.

$a1 = a2 = a3 = an = 1$

The mathematical description of I is known as selection index giving

$$I = \hat{b}_1 x_1 + \hat{b}_2 X_2 + \; ..... + \hat{b}_n x_n$$

The index values are determined, where X1, X2 ...... Xn stands for the phenotypic performance of the individual with respect to each character.

On the basis of the selection indices, the individuals were arranged in order of merit and then the best 20% were identified and recommended as superior genotypes for further breeding programme.

The expected genetic gain through selection may be given by the formula

$$\Delta G = \frac{K \underline{a}' \underline{G}ij \; \underline{b}}{(\underline{b}' \, \underline{P}ij \; \underline{b})^{1/2}}$$

Where K is the selection differential.

RESULTS

4. RESULT

The data on the observations are statistically analysed and the results are presented below.

4.1 Mean performance of the genotypes

The data collected on various characters were subjected to analysis of variance for testing significance of the varietal effects. The mean values are furnished in Tables 4.1.1 to 4.1.7.

4.1.1 Germination parameters

Significant difference was recorded among the treatments for number of days taken for the seeds to germinate (Table 4.1.1). This ranged from 3.5 (Echarikkotta) to 8.6 (PKM 1). Echarikkotta was found on par with eight varieties viz. Manglore dark green (3.8), Thrissur (3.8), Kanhangad (3.9), Fuken (3.9), Maharashtra watermelon 10(4), Kasargod (4.1), Asahi Yamato (4.1) and Arka Manik (4.1).

The variance among the varieties in the percentage of germination was also tested. The ANOVA revealed significant difference among the genotypes. This ranged from 44.7 (Thrissur) to 82.6 (Arka Manik). The varieties viz. PKM 1 (82.5), Kanhangad (82.3), Kasargod (81.6) SugarBaby (79.3), Maharashtra watermelon 10 (79.3) and Asahi Yamato (77) were on par with Arka Manik.

Table 4.1.1 Germination parameters

Genotypes	Days to germinate	Percentage of germination
Fuken	3.9	76.6
Edakkad	6.6	78.3
Kuttipuram	8.4	72.6
Asahi Yamato	4.1	77.0
Manglore light green	6.5	59.6
HW 1	6.2	65.6
Kanhangad	3.9	82.3
Sugar Baby	4.4	79.3
Manglore dark green	3.8	68.0
Maharashtra watermelon 10	4.0	79.3
Arka Manik	4.1	82.6
RW 187-2	6.1	62.0
Banglore	5.0	52.3
Nileswaram	6.6	51.7
Pallipuram	5.0	52.3
Thaliparampa	6.6	51.7
PKM 1	8.6	82.5
Thrissur	5.0	44.7
Kasargod	4.1	81.6
Echarikkotta	3.5	71.3
SE	0.27	1.93
CD	0.77	5.54

4.1.2. Growth parameters

The length of vine ranged from 3.1 m (Kanhangad, Kasargod, Edakkad, SugarBaby) to 4.7 m (PKM 1). ANOVA showed significant difference between the genotypes (Table 4.1.2). Kasargod (3.1), Edakkad (3.1), Sugar Baby (3.1), Fuken (3.3) and Pallipuram (3.8) were on par with Kanhangad.

Significant difference was observed between genotypes for internodal length which ranged from 5.8 cm (Arka Manik) to 12.4 cm (Kanhangad). Arka Manik was also on par with Sugar Baby (6.1).

All the genotypes showed significant difference for the number of primary branches. The highest number of primary branches are shown by PKM 1 (5.8) and the least by RW 187-2 (3.4). PKM 1 was on par with Arka Manik (5.2) and Sugar Baby (5.1).

4.1.3 Flowering parameters

Significant difference was observed among the genotypes for number of days to produce the first male flower (Table 4.1.3) and it ranged from 21.3 (SugarBaby) to 32.5 (PKM 1).

The node at which the first male flower produced also showed significant difference among the genotypes. The character

Table 4.1.2 Growth parameters

Genotypes	Inter-nodal length (cm)	Length of vine (cm)	Number of branches/ plant
Fuken	9.3	3.3	4.80
Edakkad	9.0	3.1	3.6
Kuttipuram	11.1	3.7	3.8
Asahi yamato	7.8	3.8	4.7
Manglore light green	11.2	3.9	3.9
HW 1	9.7	3.6	4.2
Kanhangad	12.4	3.1	4.8
SugarBaby	6.1	3.1	5.1
Manglore dark green	10.1	3.9	3.8
Maharashtra watermelon 10	12.0	3.8	4.8
Arka Manik	5.8	3.9	5.2
RW 187-2	7.8	3.9	3.4
Banglore	10.3	4.3	3.8
Nileswaram	10.9	4.3	3.8
Pallipuram	9.8	3.9	4.3
Thaliparampa	7.3	3.9	4.3
PKM 1	7.3	4.7	5.8
Thrissur	11.3	3.6	4.3
Kasargod	8.7	3.1	4.4
Echarikkotta	8.5	3.6	4.2
SE	0.32	0.12	0.25
CD	1.09	0.34	0.70

Table 4.1.3 Flowering parameters

Genotypes	Days to first male flower production	Node at which first male flower produced	Days to first female flower production	Node at which first female flower produced
Fuken	31.5	7.6	37.0	16.3
Edakkad	27.6	7.1	46.3	21.3
Kuttipuram	31.9	7.9	41.2	23.0
Azahi Yamato	25.2	5.3	31.9	13.7
Manglore light green	27.8	8.1	24.7	18.6
HW 1	28.2	8.4	36.7	17.3
Kanhangad	24.1	5.7	32.7	12.0
Sugar Baby	21.3	4.6	29.1	9.7
Manglore dark green	26.5	7.7	33.2	12.0
Maharashtra watermelon 10	28.4	8.2	38.0	19.9
Arka Manik	27.3	7.5	35.8	14.3
RW 187-2	31.3	8.6	37.4	27.2
Banglore	31.4	8.2	45.5	23.3
Nileswaram	30.2	11.2	47.2	21.8
Pallipuram	30.7	11.0	43.3	16.7
Thaliparampa	32.0	10.2	42.3	21.8
PKM 1	32.5	11.7	60.0	39.0
Thrissur	26.9	8.3	43.8	20.3
Kasargod	25.0	6.3	30.8	15.3
Echarikkotta	27.3	7.9	40.5	20.3
SE	0.92	0.49	1.00	1.63
CD	2.64	1.40	3.20	4.65

ranged from 4.6 (Sugar Baby) to 11.7 (PKM 1). Sugar Baby was on par with Asahi Yamato (5.3) and Kanhangad (5.7).

Significant difference was recorded among the treatments both in terms of the days to produce the first female/bisexual flower and the node at which the first female/bisexual flower appeared.

The days to first female/bisexual flower production ranged from 29.1 (Sugar Baby) to 60 (PKM 1). Kasargod (30.8) and Asahi Yamato (31.9) were on par with Sugar Baby. The first female/bisexual flower was produced at the lowest node in Sugar Baby (9.7) and at the highest node in PKM 1(39). Sugar Baby was on par with Manglore dark green (12), Kanhangad (12), Asahi Yamato (13.7) and Arka Manik (14.3).

4.1.4 Yield parameters

Significant difference was seen among the treatments with respect to days to first harvest and the first fruiting node (Table 4.1.4).

It was observed that the number of days for the first harvest ranged from 73.4 (Sugar Baby) to 97.3 (PKM 1). The first fruiting node ranged from 14.8 (Sugar Baby to 42.3 (PKM 1). Sugar Baby was on par with Kanhangad (17.2), and Asahi Yamato (18.9).

Table 4.1.4 Yield parameters

Genotypes	Days to first harvest	Node at which first fruit produced	Number of fruits/ plant	Weight of fruits/ plant (kg)	Weight of individual fruit (kg)
Fuken	78.9	20.2	3.6	14.4	4.0
Edakkad	82.0	25.9	3.6	10.0	3.2
Kuttipuram	80.7	27.0	3.0	4.9	3.3
Asahi Yamato	76.7	18.9	4.1	12.9	3.2
Manglore light green	78.6	24.5	2.1	6.8	3.2
HW 1	84.2	22.3	3.9	11.8	3.0
Kanhangad	80.2	17.2	2.4	7.6	3.5
Sugar Baby	73.4	14.8	4.6	13.7	3.0
Manglore dark green	82.9	25.0	2.2	5.6	2.5
Maharashtra watermelon 10	85.5	26.9	1.9	5.4	2.9
Arka Manik	86.2	22.6	2.7	10.5	3.9
RW 187-2	89.6	29.8	1.7	3.9	2.2
Banglore	86.7	32.3	1.8	3.7	2.1
Nileswaram	90.1	29.3	1.9	4.2	2.2
Pallipuram	77.9	25.6	2.0	8.1	4.0
Thaliparampa	79.2	30.4	3.6	11.6	3.2
PKM 1	97.2	42.3	2.6	8.2	3.1
Thrissur	83.2	30.3	2.4	7.6	3.3
Kasargod	78.8	24.7	2.9	10.8	3.8
Echarikkotta	76.7	27.7	1.9	4.0	3.0
SE	8.3	4.23	0.25	0.96	0.21
CD	2.6	1.48	0.70	2.76	0.59

Other yield characters like number of fruits/plant, weight of fruits/plant, weight of individual fruit and flesh thickness showed significant difference among the genotypes.

Number of fruits/plant ranged from 1.7 (RW 187-2) to 4.6 (Sugar Baby). Asahi yamato (4.1) and HW 1 (3.9) were on par with Sugar Baby. Weight of fruits/plant ranged from 3.7 (Banglore) to 14.4 (Fuken). Fuken was on par with Sugar Baby (13.7), Asahi Yamato (12.9) and HW 1 (11.8).

Weight of individual fruit was at a range of 2.1 kg (Banglore) to 4.0 kg (Fuken and Pallipuram), Arka Manik (3.9 kg), Kasargod (3.8 kg) and Kanhangad (3.5 kg) were on par with Fuken.

4.1.5 Fruit quality parameters

Three fruit shapes viz. round, oblong and oval were observed. Asahi Yamato, Kanhangad, Sugar Baby, Thrissur and Echarikkotta produced round fruits whereas, majority of the genotypes, viz. Fuken, Edakkad, Kuttippuram, Manglore light green, Manglore dark green, Maharashtra watermelon 10,Arka Manik, RW 187-2, Banglore, Neeleswaram, Pallipuram, Thaliparampa and Kasargod produced oblong fruits. HW 1 and PKM 1 produced oval shaped fruits.

Table 4.1.5 Fruit and quality parameters

Genotypes	Flesh thickness (cm)	Rind thickness (mm)	Total soluble solids (%)	Number of seeds/ fruit	100-seed weight (g)
Fuken	8.0	3.7	9.3	312.3	4.3
Edakkad	7.3	2.7	8.3	176.7	1.5
Kuttipuram	7.2	3.7	7.8	223.0	3.2
Asahi Yamato	7.0	3.0	11.2	343.0	4.3
Manglore light green	7.1	4.7	8.0	253.6	2.8
HW 1	6.7	3.0	10.2	336.3	2.2
Kanhangad	7.1	3.0	9.8	170.7	1.6
Sugar Baby	7.1	2.0	11.9	365.0	3.5
Manglore dark green	6.3	3.7	8.8	340.3	3.7
Maharashtra watermelon-10	6.5	4.7	10.4	321.6	2.2
Arka Manik	8.2	2.0	11.3	219.3	5.6
RW 187-2	6.4	3.3	10.2	265.7	3.4
Banglore	6.0	3.0	9.9	345.0	3.7
Nileswaram	6.1	4.3	8.6	318.7	3.6
Pallipuram	8.2	3.3	10.0	317.3	2.6
Thaliparampa	7.2	3.7	8.3	311.6	4.1
PKM 1	7.3	2.3	8.6	185.0	9.4
Thrissur	7.6	3.0	11.0	242.3	3.7
Kasargod	8.0	4.7	10.8	318.6	2.6
Echarikkotta	6.4	4.0	10.0	140.6	2.1
SE	0.17	0.22	0.24	8.80	0.04
CD	0.48	0.63	0.68	25.18	0.12

Rind colour of the fruit ranged from light green to dark green with characteristic stripes (Plate 1-4). Fuken, Mangalore light green, Asahi Yamato, and Thrissur produced light green fruits. The fruit of Sugar Baby was bluish green in colour. PKM 1, Kanhangad, Kasargod, Maharashtra watermelon 10 and Manglore dark green produced dark green fruits. Fruits of all other varieties were seen with stripes of dark and light green colours.

Flesh firmness was maximum in Fuken whereas Maharashtra watermelon 10 scored the least flesh firmness.

The flesh colour ranged from dark pink to light pink. Sugar Baby produced fruits with dark pink flesh. Pallipuram had fruits with light pink flesh. All the other genotypes had flesh colours varying from dark pink to light pink.

Analysis of variance showed significant differences between the genotypes for flesh thickness (Table 4.1.5). It ranged from 6.0 cm (Banglore) to 8.23 cm (Pallipuram). Pallipuram was on par with Arka Manik (8.2 cm) Fuken (8.0 cm) and Kasargod (8 cm).

Analysis of variance showed that there is significant difference between varieties for rind thickness. Sugar Baby and Arka Manik showed minimum rind thickness of 2.0 mm. PKM 1 (2.3 mm) is on par with Arka Manik and Sugar Baby.

Table 4.1.6 Fruit flesh firmness in various genotypes of watermelon

Genotypes	Character of flesh
Fuken	Firm and crips
Edakkad	Soft
Kuttipuram	Soft
Asahi Yamato	firm and crisp
Manglore light green	Soft
HW 1	Soft
Kanhangad	Soft
Sugar Baby	Firm and crisp
Manglore dark green	Soft
Maharashtra watermelon 10	Soft and loose
Arka Manik	Soft
RW 187-2	Soft
Banglore	Soft
Nileswaram	Soft
Pallipuram	Soft
Thaliparampa	Soft
PKM 1	Soft
Thrissur	Soft
Kasargod	Soft
Echarikkotta	Soft

The mean value of TSS ranged from 7.8 (Kuttipuram) to 11.9 (SugarBaby). Arka Manik (11.3) was on par with Sugar Baby.

4.1.6 Seed characters

Results on the seed characters viz. number of seeds/ fruit and 100 seed weight are presented in Table 4.1.5. Both these characters showed significant differences among the genotypes.

Number of seeds/fruit ranged from 140.6 (Echarikkotta) to 365.0 (Sugar Baby). Sugar Baby was on par with Banglore (345), Asahi Yamato (343) and Manglore dark green (340.3).

100 seed weight ranged from 1.5g (Edakkad) to 9.4g (PKM 1) Edakkad was on par with Kanhangad (1.6 g).

4.1.7 Reaction towards pests and diseases

All the genotypes were found equally susceptible to fruitfly especially in the initial stages. Similarly, all the varieties were moderately susceptible to serpentine leaf minor also.

Among the diseases, Fusarium wilt caused by *Fusarium oxysporum* was found to be the serious one. Varieties viz. HW 1, Manglore light green, Manglore dark green, Banglore and Maharashtra watermelon 10 were found to be highly susceptible to

Table 4.1.7 Fusarium wilt incidence in watermelon

Genotypes	Disease score
Fuken	0
Edakkad	0
Kuttipuram	0
Asahi Yamato	0
Manglore light green	3
HW 1	3
Kanhangad	0
Sugar Baby	0
Manglore dark green	3
Maharashtra watermelon 10	3
Arka Manik	1
RW 187-2	1
Banglore	3
Nileswaram	1
Pallipuram	0
Thaliparampu	1
PKM 1	1
Thrissur	1
Kasargod	2
Echarikkotta	1

0 - Resistant
1 - Moderately resistant
2 - Less resistant
3 - Susceptible

this diseases. Sugar Baby, Asahi Yamato, Edakkad, Kuttipuram, Pallipuram Kanhangad and Fuken were found to be free from this disease. All other genotypes were moderately resistant except Kasargod, which was less resistant.

An unidentified virus diseases was observed in the crop. The diseased plants produced symptoms viz. yellowing, crinkling and dieback of tip of the vine. The affected plant also exhibited splitting of vines. Finally the plants wilted completely. Varieties viz. Manglore light green and Manglore dark green were found to be highly susceptible to this virus. All other genotypes were free from this disease.

4.2 Variability

The variability was assessed as genotypic and phenotypic variance and genotypic and phenotypic coefficients of variations. The data are furnished in Table 4.2.

Number of seeds/fruit showed the highest genotypic variance (4658.4) followed by percentage of germination (147.3) and days to first female flower production (51.1). Lowest value was recorded for length of vine (0.2) followed by weight of individual fruits (0.3). The phenotypic variance was also maximum for number of seeds/fruit (4890.4) followed by percentage of germination (158.5). Lowest phenotypic variance was noticed for the length of vine (0.2) followed by weight of individual fruit (0.4).

The maximum genotypic coefficient of variation was registered by 100 seed weight (48.9) followed by weight of fruits/plant and node at which first female flower was produced (32.9). The least genotypic coefficients of variation was recorded by percentage of germination (0.1) followed by (9.2) days to first fruit harvest (6.5).

Hundred seed weight recorded maximum phenotypic coefficients of variation (48.9) followed by weight of fruits/plant (42.7) and node at which first female flower was produced (35.9). Days taken for the first fruit harvest (6.6) registered least phenotypic coefficient of variation.

4.2.1 Heritability

Generally high estimates of heritability were recorded for all the characters (Table 4.2). Among the different characters studied, 100 seed weight recorded, maximum heritability (99%) followed by weight of individual fruit (98%) and days to first harvest (97%). The minimum heritability was recorded by number of branches/plant (67%).

Table 4.2 Genetic parameters of water melon cultivars

Characters	og^2	oe^2	op^2	H^2 %	GA %	GCV %	PCV %
Days to germinate	2.4	0.2	2.6	91	3.0	0.1	31.3
Percentage of germination	147.3	11.2	158.5	92	24.1	17.8	18.5
Days to first male flower production	8.5	2.6	11.0	77	5.3	10.3	11.7
Node at which first male flower was produced	3.3	0.7	4.0	82	3.4	22.4	24.8
Days to first female flower production	51.1	3.6	54.7	93	14.2	18.2	18.8
Node at which first female flower was produced	40.6	7.7	48.3	84	12.0	32.9	35.9
Internodal length (cm)	3.3	0.4	3.7	89	3.5	19.6	20.8
Length of vine (m)	0.2	0.1	0.2	80	0.6	11.3	12.6
Node at which first fruit was produced	34.2	6.5	40.7	84	11.0	22.6	24.7
Number of branches/plant	0.3	0.2	0.5	67	1.0	13.8	16.0
Number of fruits/plant	0.7	0.2	0.8	79	1.5	30.0	33.9
Weight of fruit/plant (kg)	10.7	2.9	13.5	79	6.0	38.1	42.7
Weight of individual fruit(kg)	0.3	0.1	0.4	98	1.0	18.3	21.7
Flesh thickness (cm)	0.4	0.1	0.5	84	1.2	9.2	10.1
Rind thickness (mm)	0.6	0.1	0.8	81	1.5	23.3	25.9
TSS (%)	1.4	0.2	1.6	89	2.3	12.1	12.8
Number of seeds/fruit	4658.4	232.2	4890.4	95	137.1	24.8	25.3
100 seed weight (g)	2.9	0.1	2.9	99	3.5	48.9	48.9
Days to first harvest	29.5	1.0	30.5	97	11.0	6.5	6.6

4.2.2 Genetic advance

Number of seeds/fruit only showed a high value of genetic advance (137.1) and all other plant characters recorded below 50 per cent of genetic advance (Table 4.2). Length of vine/plant showed minimum value of genetic advance (0.6).

4.3 Correlation studies

The genotypic, phenotypic and error correlation coefficient between fruit yield/plant, TSS and days taken for the first fruit harvest with other characters were studied. The data are presented in the Tables 4.3.1, 4.3.2, 4.3.3 and Fig. 1 to 3.

4.3.1 Genotypic correlation

The total weight of fruits/plant displayed positive genotypic correlation with number of fruit/plant (0.9264), weight of individual fruit (0.7314), flesh thickness (0.6636), number of branches/plant (0.5670), percentage of germination (0.5158), TSS (0.2489), number of seeds/fruit (0.2238) and 100 seed weight (0.118).

Yield/plant was negatively correlated with the days to first harvest (-0.6090), node at which first fruit was produced (-0.5840), length of vine (-0.5265), internodal length (-0.4627),

Table 4.3.1 Phenotype, genotypic and error correlation coefficient between yield/plant and other characters

Characters	Phenotypic correlation	Genotypic correlation	Error correlation
Days to germinate	-0.0703	-0.0826	0.0010
Percentage of germination*	0.4130**	0.5158	-0.2463
Days to first male flower production	-0.2693*	-0.2785	-0.2373
Node at which first male flower was produced	-0.3905**	-0.4154	-0.2877*
Days to first female flower production	-0.3136**	-0.3947	-0.1482
Node at which first female flower was produced	-0.2904**	-0.3762	0.0548
Internodal length	-0.3805**	-0.4627	0.0424
Length of vine	-0.3866**	-0.5265	0.1583
Node at which first fruit was produced	-0.4456**	-0.5840	0.1705
Number of branches/plant	0.3701**	0.5670	-0.1659
Number of fruit/plant	0.9105**	0.9263	0.8512**
Weight of individual fruit	0.6818**	0.7314	0.5397*
Flesh thickness	0.5940**	0.6636	0.2906*
Rind thickness	-0.3545**	-0.4045	-0.1518
Total soluble solid(TSS)	0.1930	0.2489	-0.1068
Number of seeds/fruit	0.1863	0.2238	-0.0839
100 seed weight	0.1040	0.1189	-0.0927
Days to first harvest	-0.5400**	-0.6090	-0.0748

* Significant at 1% level

** Significant at 5% level

Figure 1

X_1 - Days to germinate

X_2 - Percentage of germination

X_3 - Days to first male flower production

X_4 - Node at which first male flower was produced

X_5 - Days to first female flower production

X_6 - Node at which first female flower was produced

X_7 - Internodal length

X_8 - Length of vine

X_9 - Node at which first fruit was produced

X_{10} - Number of branches/plant

X_{11} - Number of fruits/plant

X_{12} - Weight of fruits/plant

X_{13} - Flesh thickness

X_{14} - Rind thickness

X_{15} - TSS

X_{16} - Number of seeds/fruit

X_{17} - 100 seed weight

X_{18} - Days to first harvest

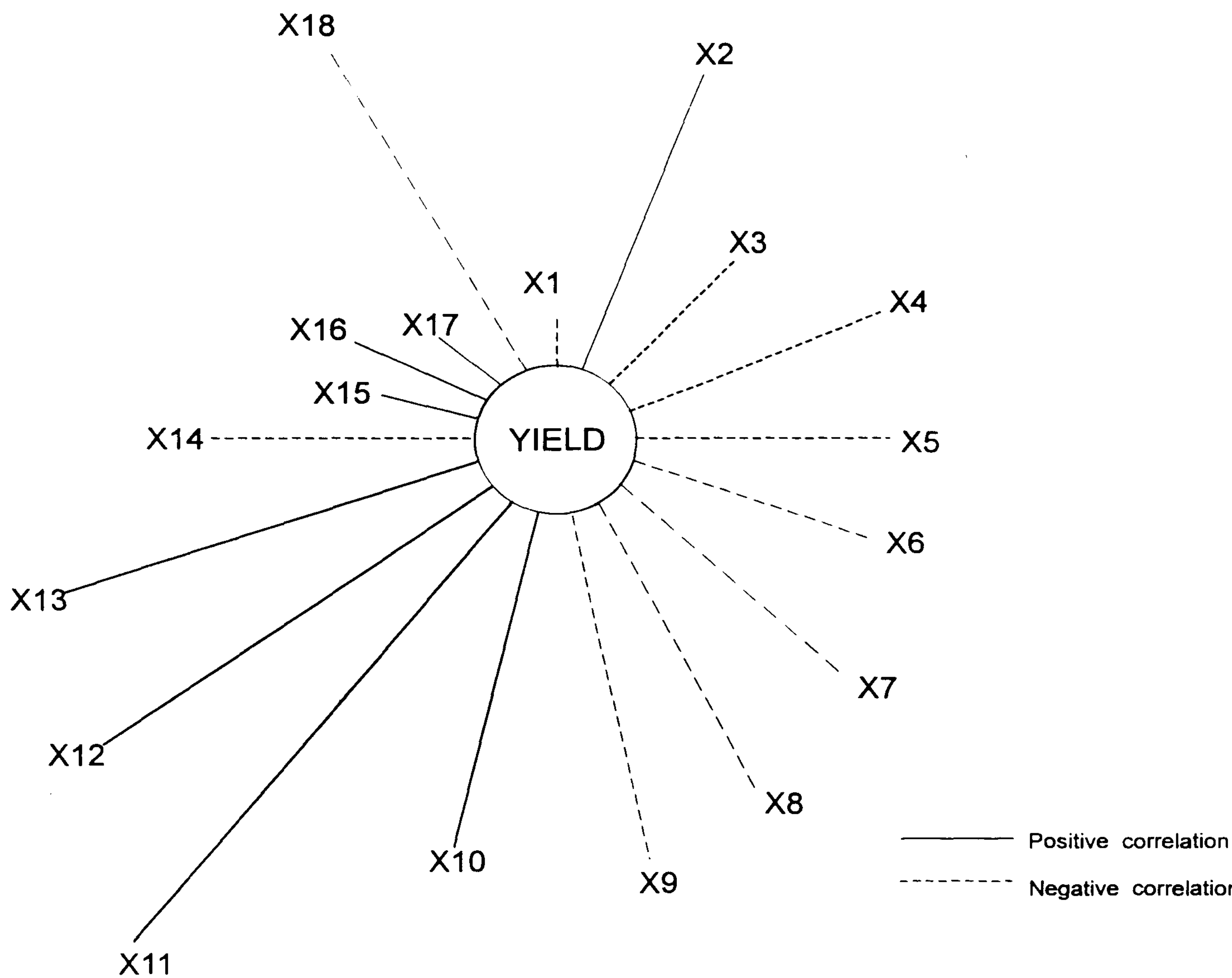

Fig. 1. Genotypic correlation coefficient between yield and other characters

rind thickness -(0.4045), node at which first female flower was produced (-0.3762), days to produce first female flower (-3947), days to produce first male flower (-0.2785) and days to germinate (-0.0826). TSS had positive correlation with days to germinate (0.4673), number of branches/plant (0.4554), percentage of germination (0.3490), number of seeds/fruit (0.2993), number of fruit/plant (0.2690), weight of fruit/plant (0.2489), flesh thickness (0.2034) and weight of individual fruit (0.1307).

TSS was negatively correlated with the characters viz. days to first male flower production (-0.6528), node at which first male flower was produced (-0.5393), node at which first female flower was produced (-0.4992), days to first female flower production (-0.4855), node at which first fruit was produced (-0.4524), internodal length (-0.3986), rind thickness (-0.3511), length of vine (-0.3168), days to first harvest (-0.2117) and 100 seed weight (-0.0445).

Earliness in terms of days to first fruit harvest was positively correlated with node at which first fruit was produced (0.8062), node at which first male flower was produced (0.8044), days to first female flower production (0.7781), node at which first female flower was produced (0.7322), length of vine (0.7159), days to first male flower production (0.6411), 100 seed weight (0.4842), days to germinate (0.1327) and internodal length (0.0846).

Days to first fruit harvest was negatively correlated with number of fruits/plant (-0.6090), weight of individual fruit (-0.3070), number of seeds/fruit (-0.2529), flesh thickness (-0.2191), total soluble solid (-0.2117), percentage of germination (-0.1458) rind thickness (-0.0821) and number of branches/plant (-0.0077).

4.3.2 Phenotypic correlation

Fruit yield/plant had a significant positive phenotypic correlation with number of fruit/plant (0.9105), weight of individual fruit (0.6818), flesh thickness (0.5940), percentage of germination (0.4130), and number of branches/plant (0.3701).

Yield/plant had a significant negative phenotypic correlation with days to first harvest (-0.5400), node at which first fruit was produced (-0.4456), node at which first male flower was produced (-0.3905), length of vine (-0.3866), internodal length (-0.3805), rind thickness (-0.3545), days to produce first female flower (-0.3136), node at which first female flower was produced (-0.2904) and days to produce first male flower (-0.2693).

TSS had a significant phenotypic positive correlation with the characters namely days to germinate (0.4258), number of branches/plant (0.3393), number of seeds/fruit (0.2842) and number of fruits/plant (0.2232).

Table 4.3.2 Phenotypic, genotypic and error correlation coefficient between total soluble solid and other characters

Characters	Phenotypic correlation	Genotypic correlation	Error correlation
Days of germinate	0.4258**	0.4673	-0.0407
Percentage of germination*	0.3162**	0.3490	-0.0122
Days to first male flower production	-0.5061**	-0.6528	0.2091
Node at which first male flower was produced	-0.4608**	-0.5393	-0.0018*
Days to first female flower production	-0.4536**	-0.4855	-0.1298
Node at which first female flower was produced	-0.4399**	-0.4992	-0.0689
Internodal length	-0.3474**	-0.3986	0.0559
Length of vine	-0.2812**	-0.3168	-0.0959
Node at which first fruit was produced	-0.3974**	-0.4524	-0.0486
Number of branches/plant	0.3393**	0.4554	-0.0641
Number of fruit/plant	0.2232*	0.2690	-0.0134
Weight of fruit/plant	0.1930	0.2489	-0.1068
Weight of individual fruits	0.0707	0.1307	-0.1883
Flesh thickness	0.1427	0.2034	-0.2434
Rind thickness	-0.3210**	-0.3511	-0.1580
Number of seeds/fruit	0.2842**	0.2993	0.1274
100 seed weight	-0.0417	-0.0445	0.0139
Days to first harvest	-0.2025	-0.2127	0.1865

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

Figure 2 Genotypic correlation coefficient between TSS and other characters

X_1 - Days to germinate

X_2 - Percentage of germination

X_3 - Days to first male flower production

X_4 - Node at which first male flower was produced

X_6 - Days to first female flower production

X_6 - Node at which first female flower was produced

X_7 - Internodal length

X_8 - Length of vine

X_9 - Node at which first fruit was produced

X_{10} - Number of branches/plant

X_{11} - Number of fruits/plant

X_{12} - Weight of fruits/plant

X_{13} - Weight of individual fruit

X_{14} - Flesh thickness

X_{15} - Rind thickness

X_{16} - Number of seeds/fruit

X_{17} - 100 seed weight

X_{18} - Days to first harvest

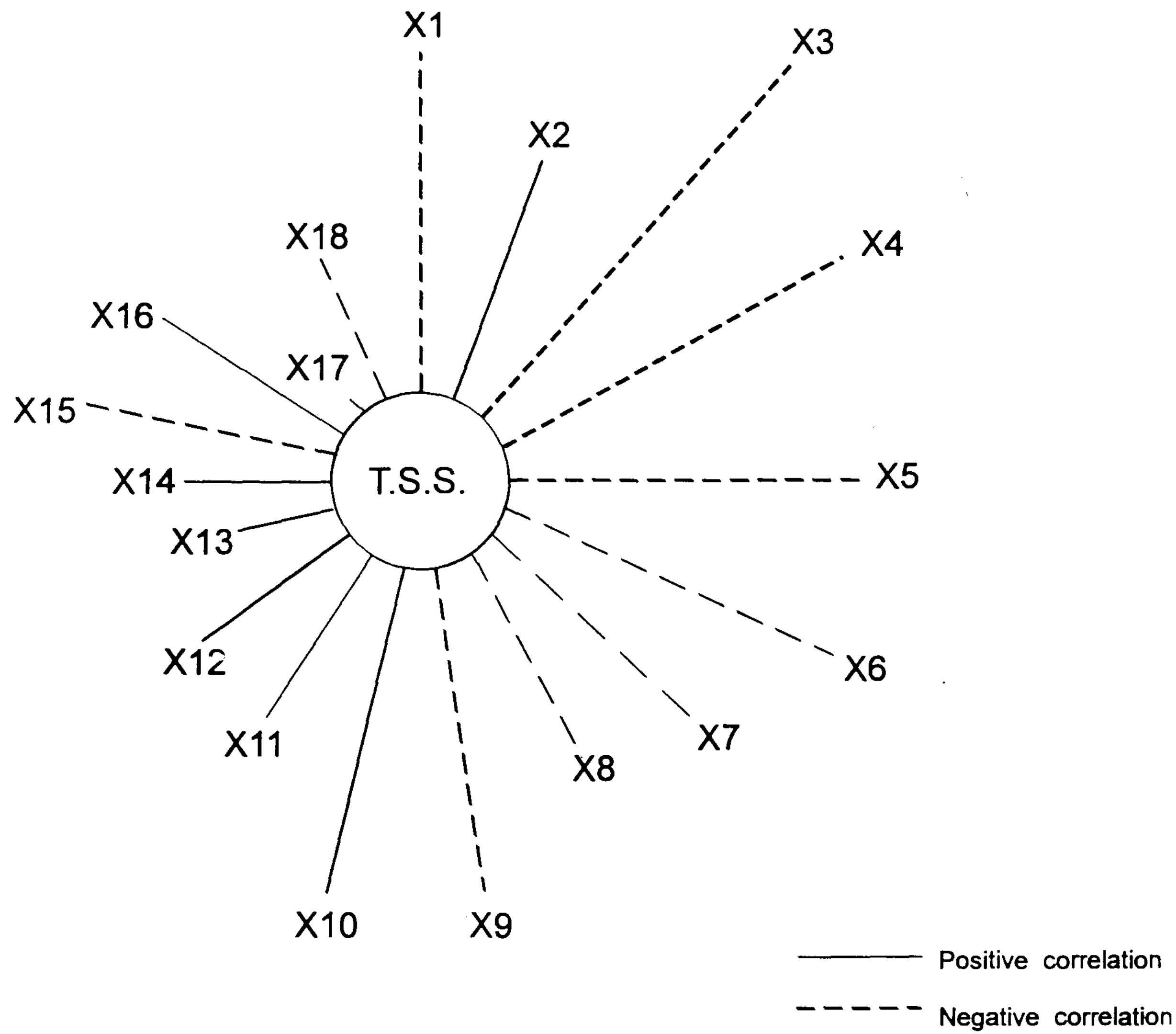

Fig. 2. Genotypic correlation coefficient between T.S.S. and other characters

Table 4.3.3 Phenotypic, genotypic and error correlation coefficient between days to first fruit harvest and other plant character.

Characters	Phenotypic correlation	Genotypic correlation	Error correlation
Days to germinate	0.1338	0.1327	0.1706
Percentage of germination	-0.1466	-0.1458	-0.1764
Days to first male flower production	0.5474*	0.6411	-0.0660
Node at which first male flower was produced	0.7218**	0.8044	0.0732
Days to first female flower production	0.7329**	0.7781	-0.1542
Node at which first female flower was produced	0.6625**	0.7322	0.0426
Internodal length	0.0830	0.0846	0.0782
Length of vine	0.6285**	0.7159	-0.0151
Node at which first fruit was produced	0.7265**	0.8062	-0.0064
Number of branches/ plant	-0.0143	-0.0077	-0.0794
Number of fruit/plant	-0.5605**	-0.6306	-0.1171
Weight of fruit/plant	-0.5400**	-0.6090	-0.0748
Weight of individual fruit	-0.2506*	-0.3070	0.0505
Flesh thickness	-0.1900	-0.2191	0.1015
Rind thickness	-0.0799	-0.0821	-0.0924
Total soluble solid*	-0.2075	-0.2117	-0.1865
Number of seeds/fruit	-0.2475*	-0.2529	-0.1194
100 seed weight	0.4747**	0.4842	-0.1734

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

Figure 3 Genotypic correlation coefficient between earliness and other plant characters

X_1 - Days to germinate

X_2 - Percentage of germination

X_3 - Days to first male flower production

X_4 - Node at which first male flower was produced

X_6 - Days to first female flower production

X_6 - Node at which first female flower was produced

X_7 - Internodal length

X_8 - Length of vine

X_9 - Node at which first fruit was produced

X_{10} - Number of branches/plant

X_{11} - Number of fruits/plant

X_{12} - Weight of fruits/plant

X_{13} - Weight of individual fruit

X_{14} - Flesh thickness

X_{15} - Rind thickness

X_{16} - TSS

X_{17} - Number of seeds/fruit

X_{18} - 100 seed weight

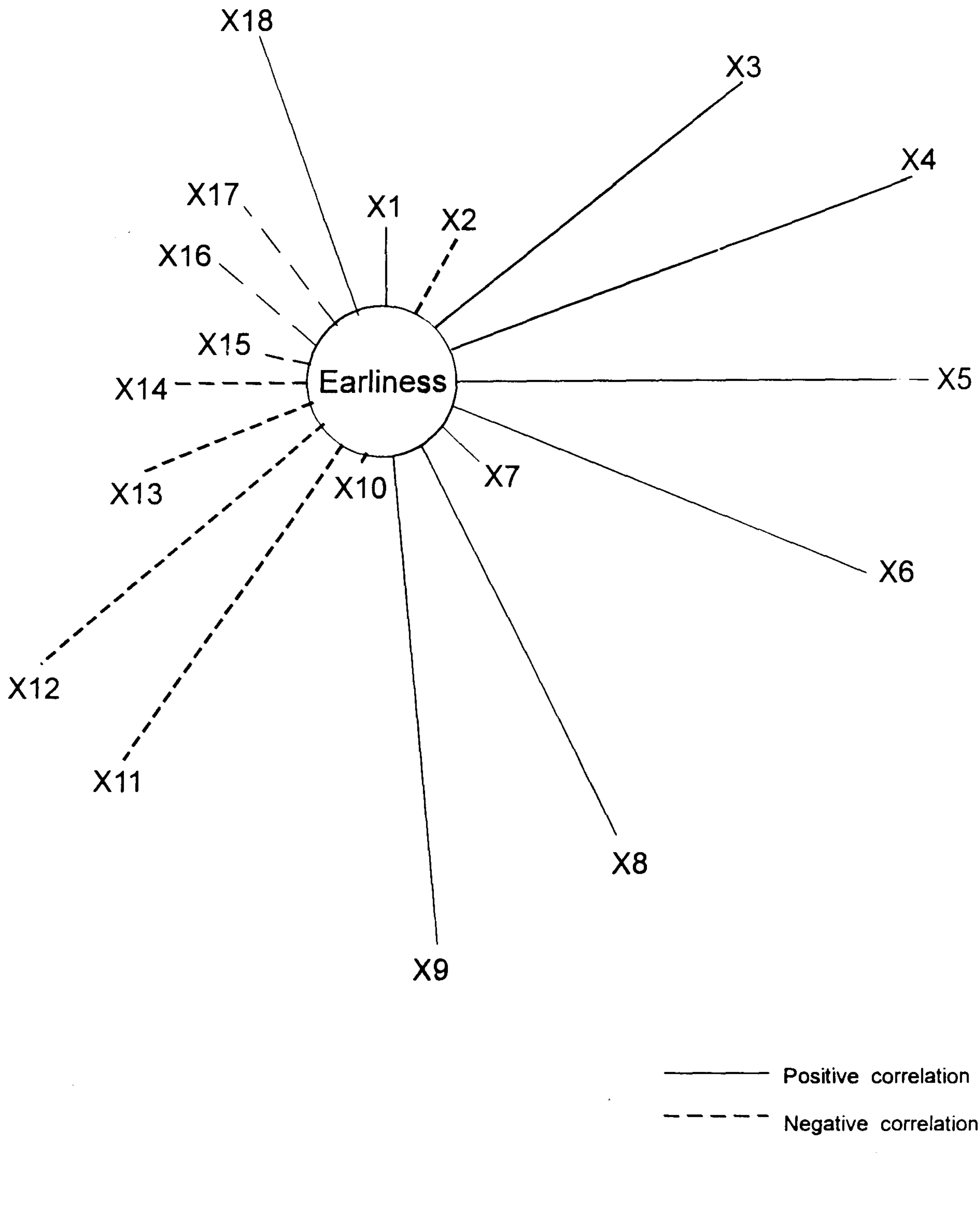

Fig. 2. Genotypic correlation coefficient between earliness and other characters

TSS had a significant negative phenotypic correlation with days to produce first male flower (-0.5061), node at which first male flower was produced (-0.4608), days to produce first female flower (-0.4536), node at which first female flower was produced (-0.4399), days to germinate (-0.4258), node at which first fruit was produced (-0.3974), internodal length (-0.3424), rind thickness (-0.3210) and length of vine (-0.2812).

Days to first fruit harvest had a highly significant and positive phenotypic correlation with node at which first male flower was produced (0.7329), node at which first fruit was produced (0.7265), node at which first female flower was produced (0.6625), length of vine (0.6285), days to produce first male flower (0.5474) and 100 seed weight (0.4747).

Days to first fruit harvest displayed negative and significant phenotypic correlations with number of fruit/plant (-0.5605), weight of fruits/plant (-0.5400), weight of individual fruit (-0.2506) and number of seeds/fruit (-0.2425).

4.3.4 Error Correlation

Weight of fruits/plant had significant positive error correlation with number of fruits/plant (0.8512), weight of individual fruit (0.5397) and flesh thickness (0.2906). While node at which first male flower was produced had a negative significant error correlation (-0.2877) with yield/plant. Error correlation between fruit yield/plant with all other plant characters were found insignificant.

4.4 Path coefficient analysis

Path coefficient analysis was done using total weight of fruits/plant as effects and characters such as node at which first female flower was produced, internodal length, length of vine, number of branches/plant, number of fruits/plant weight of individual fruit and flesh thickness as causal factors (Table 4.4 and Fig. 4).

4.4.1 Direct effects

Among the different causal factors, number of fruits/plant recorded maximum direct effect (0.7546), followed by weight of individual fruit (0.3203). The direct effects of other factors viz. internodal length (0.0013), number of branches/plant (0.0036) and flesh thickness (0.0806) were very meagre. The characters, node at which first female flower was produced (-0.0088) and length of vine (-0.0030) registered negative direct effect on yield.

4.4.2 Indirect effects

The node number at which first female flower was produced exerted negative indirect effect through all other characters.

Internodal length also recorded negative indirect effect through all other characters except node at which first female flower was produced (0.0001) and length of vine (0.0002).

Length of vine/plant also recorded negative indirect effect through all other causal factors except flesh thickness (0.0382).

Number of branches/plant showed maximum indirect effect through number of fruits/plant (0.3136) followed by weight of individual fruits (0.2021) and flesh thickness (0.0474) and negative indirect effect through internodal length (-0.0005).

Number of fruits/plant exerted maximum indirect effect through weight of individual fruit (0.1384) followed by flesh thickness (0.0284) and negative indirect effect through internodal length (-0.0007).

Weight of individual fruit recorded maximum indirect effect through number of fruits/plant (0.3262) and negative indirect effect through internodal length (-0.0024).

Flesh thickness showed maximum indirect effect through weight of individual fruit (0.3123) followed by number of fruits/plant (0.2658) and negative indirect effect through internodal length (-0.0004).

Table 4.4 Path analysis - Direct and indirect effects

X_1	X_2	X_3	X_4	X_5	X_6	X_7	γ XY
-0.0088	-0.0001	-0.0021	-0.0003	-0.2485	-0.1004	-0.0161	-0.3762
0.0001	0.0013	0.0002	-0.0013	-0.4027	-0.0372	-0.0230	-0.4623
-0.0062	-0.0001	-0.0030	-0.0001	-0.3102	-0.1687	0.0382	-0.5265
0.0007	-0.0005	0.0001	0.0036	0.3136	0.2021	0.0474	0.5670
0.0029	-0.0007	0.0012	0.0015	0.7546	0.1384	0.0284	0.9263
0.0028	-0.0024	0.0016	0.0023	0.3262	0.3203	0.0787	0.7295
0.0018	-0.0004	0.0014	0.0021	0.2658	0.3123	0.0806	0.6636

X1 - Node at which first female flower was produced
X2 - Internodal length
X3 - Length of vine
X4 - Number of branches/plant
X5 - Number of fruits/plant
X6 - Weight of individual fruit
X7 - Flesh thickness
Y - Total weight of fruits/plant

The underlined values indicate the direct effects and the other shows indirect effects

Fig. 4 Path diagram showing direct effect and residual effect in watermelon

y - Total weight of fruits/plant

X_1 - Node at which first female flower was produced

X_2 - Internodal length

X_3 - Length of vine

X_4 - Number of branches/plant

X_6 - Number of fruits/plant

X_6 - Weight of individual fruit

X_7 - Flesh thickness

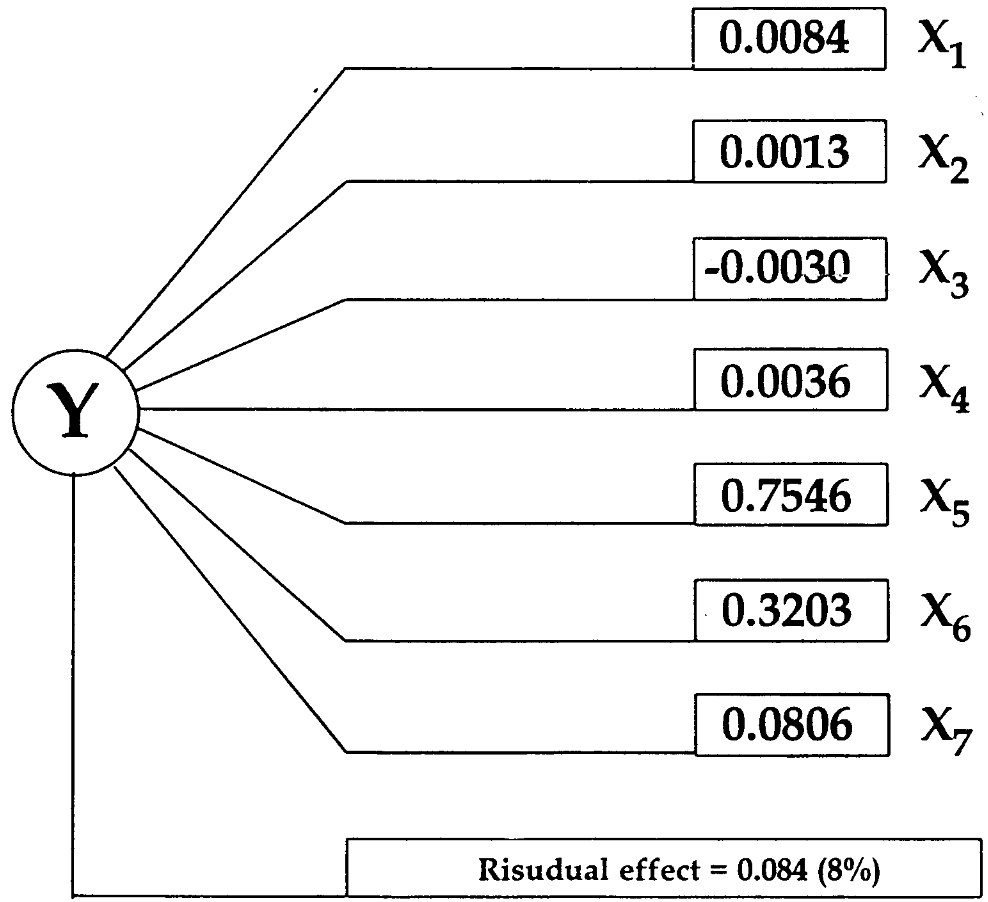

Fig. 4. Path diagram showing direct and residual effect in watermelon

About 92 per cent of the variation in fruit yield/plant was through the direct and indirect effect of the above seven component characters considered for path analysis.

4.5 Discriminent function analysis

Estimates of selection indices and ranking of genotypes based on yield and quality parameters are presented in Table 4.5. Twenty per cent of selection was exercised and the genotypes Sugar Baby (125.9), Asahi Yamato (115.4), HW 1 (109.4) and Fuken (109.3) were identified as superior genotypes.

Table 4.5 Genotypes and their selection indices in descending order

Genotypes in descending order	Selection indices
Sugar Baby	125.9
Asahi Yamato	115.4
HW 1	109.4
Fuken	109.3
Arka Manik	107.4
Kasargod	106.4
Thaliparampa	101.4
Thrissur	99.0
Edakkad	96.9
Kanhangad	96.8
Kuttipuram	94.7
PKM 1	92.7
Maharashtra watermelon 10	88.6
Manglore light green	85.8
Manglore dark green	84.4
RW 187-2	80.8
Echarikkotta	80.6
Banglore	78.6
Nileswaram	77.4
Pallipuram	76.5

DISCUSSION

5. DISCUSSION

Watermelon (Citrullus lanatus (Thunb.) Mansf. is one of the vegetables, perhaps, popularised recently in Kerala. Though its cultivation is standardized in most of the northern tracts of this state much attention has not been given in the southern region. Being the only dessert vegeable crop of this state, it deserves a lot of fundamental studies so as to gather information on various aspects of varietal adaptation. Results of such basic studies may definitely help the breeders to formulate systematic breeding programmes in future with special reference to Kerala.

Crop improvement means, improving all the desirable traits of an existing genotype by altering the genetic make up. Introduction, selection, heterosis breding, polyploidy breeding and the mutation breeding are the important plant breeding methods. Selection is reported as one of the most important breeding methods employed to identify superior varieties/types in watermelon (Seshadri 1986). For improving the efficiency of selection, information on the available genetic variability, heritability and genetic advance of different economically important traits and its association, cause and effect relationship and the selection index are necessary.

The present study was conducted with a view to identify the superior genotype of watermelon, based on systematic genetic evaluation so as to popularise them in the southern region of Kerala. The extent of variability, heritability and genetic advance of important traits, correlation among characters, path coefficient analysis, and discriminent function analysis were carried out with a view to suggest measures to bring about genetic improvement for yield and its components. The results are discussed hereunder:

5.1 Variability

Variability is the law of nature. Phenotypic variability is the measurable variability which is the result of gentic and environmental effects. The variability can be broadly classified into heritable and non heritable components. Heritability in conjunction with genetic advance would provide better information on the criteria for selection (Johnson et al. 1955).

The analysis of variance in the present study showed significant differences for all the characters viz., days to germinate, percentage of germination, internodal length, length of vine, number of branches/plant, days to first male flower production, node at which first male flower was produced, days to first female flower production, node at which first female flower was produced, number of fruits/plant, weight of individual fruit, day to first harvest, flesh thickness, rind thickness, number of seeds/fruit, and seed weight indicating the existence of wide differences between the genotypes tested. Similar difference for various characters were reported earlier by Burton et al. (1971), Jose et al. (1978) Santhipriya (1991) and Rajendran and Thamburaj (1994). High genotypic and phenotypic variances were observed for the characters viz., number of seeds/fruit and percentage of germination. High genotypic and phenotypic variances recorded for number of seeds/fruit is in agreement with the findings of Mariappan and Pappiah (1990) in cucumber.

The extent of genetic variability of quantitative characters measured in different scales from a population can be compared by estimating genotypic coefficient of variation. Moderate phenotypic and genotypic coefficient of variations were observed for the character weight of fruits/plant and 100 seed weight, indicating the presence of moderate amount of genetic variability. However, Laltaprasad et al. (1988) observed high genotypic and phenotypic coefficients of variation for the same characters under the conditions of U.P. and Coimbatore respectively. Every crop has its own congenial conditions for its successful growth. The climatic conditions existing in southern Kerala did not allow the crop to fully express all the characters. So the low genotypic and phenotypic coefficients of variation for weight of fruits/plant and 100 seed weight might be due to the special environmental and climatic conditions prevailing in South Kerala. All other characters viz., days to germinate, percentage of germination, internodal length, length of vine, number of branches/plant, days to first male flower production, node at which first male flower was produced, days to first female flower production, node at which first female flower was produced, node at which first fruit was produced, number of fruits/plant, weight of individual fruit, days to first harvests, flesh thickness, rind thickness and number of seeds/fruit exhibited low phenotypic and genotypic coefficient of variation. This is in agreement with Swamy et al. (1985).

5.2. Heritability

Burton (1952) suggested that genotypic coefficient of variation along with heritability will give a clear idea about the amount of genetic advance to be expected by selection. Allard (1960) suggested that gain from selection for a particular character depends largely on the heritability of the character. High heritability values indicate highly heritable nature and minimum influence of the environment on the expression of the character. In the present study, high heritability values were observed for all the characters.

High heritability values for germination parameters viz. days to germinate and percentage of germination is in agreement with the findings of Chacko (1992) in muskmelon under South Kerala condition. High heritability estimates for growth parameters viz. internodal length, length of vine and number of branches/vine support the results of Thakur and Nandpuri (1974). Deol et al. (1981) reported high heritability for main stem length and moderate heritability for number of branches/plant. Swamy et al. (1985) reported low heritability for number of branches/plant in muskmelon. Flowering parameters also showed high heritability estimate which is in agreement with Vashistha et al. (1983).

High heritability estimates observed in the present investigation for the yield characters viz., number of fruits/plant, yield/plant and weight of individual fruit are in agreement with Sachan and Tikka (1974) Laltaprasad et al. (1988), Rajendran and Thamburaj (1994), Deol et al. (1981), Kalloo et al. (1981) and Swamy et al. (1985). Number of days for first harvest also exhibited high heritability value, which is in agreement with Thakur and Nandpuri (1974), whereas swamy et al. (1985) reported moderate heritability for days to first harvest.

Flesh thickness exhibited high heritability value, which is in conformity with the result of Vashistha et al.

(1983). High heritability estimates observed for number of seeds/fruit is in conformity with the result of Thakur and Nandpuri (1974) and Rajendran and Thamburaj (1994). 100 seed weight also recorded high heritability value. This is in agreement with the results of Thakur and Nandpuri (1974), Laltaprasad et al. (1988) and Rajendran and Thamburaj (1994).

High heritability estimate recorded in the present experiment for TSS is in conformity with the result of Thakur and Nandpuri (1974), Deol et al. (1981) and Swamy et al. (1985).

5.3. Genetic advance

Along with the heritability estimate, the genetic advance should also be considered for identifying characters during selection. High genetic advance was observed in the present study only for number of seeds/fruit and which is in conformity with the results of Thakur and Nandpuri (1974), Deol et al. (1981), Laltaprasad et al. (1988) and Rajendran and Thamburaj (1994). All other characters recorded very low genetic gain. Low genetic advance recorded for number of primary branches/plant is in agreement with the result of Deol et al. (1981) and Swamy et al. (1985). Low genetic advance for length of vine recorded in the present study is in agreement with the results of Swamy et al. (1985).

Low genetic advance recorded in the present study for the days to first harvest is in conformity with the result of Deol *et al*. (1981). Similarly, very low genetic gain recorded for number of fruits/plant and yield/plant is in conformity with the results of Thakur and Nandpuri (1974). The quality parameter, TSS studied in the present experiment also recorded very low gentic advance and which is in conformity with the result of Thakur and Nandpuri (1974), Deol *et al*. (1981), Lippert and Hall (1982) and Swamy *et al*. (1985).

5.4. Correlation

Correlation provides information on the nature and extent of relationship between characters. The component characters also show inter-correlations. So, when the breeder applies selection for a particular trait, the population under selection is not only improved for that trait, but also the characters associated with it. Therefore, analysis of yield in terms of genotypic, phenotypic and error correlation coefficient of component character leads to the understanding of characters that can form the basis of selection. The genotypic correlations provide a reliable measure of genetic association between the character and help to differentiate the vital association useful in breeding from nonvital ones (Falconer, 1981).

As for as watermelon is concerned, high yield/plant, earlines and high TSS are the important characters considered for selection. The correlation between these economic characters with other characters are discussed below.

5.4.1 Correlation coefficient of yield/plant with other characters

Yield/plant recorded high positive genotypic correlation with number of fruits/plant, number of branches/plant, weight of individual fruit, flesh thickness and percentage of germination. Yield/plant also recorded high negative genotypic correlation with length of vine, node at which first fruit produced and days to first harvest. High positive genotypic correlation observed in this study for yield with number of primary branches/plant is in agreement with the finding of Sachan and Tikka (1971) and Swamy et al. (1985). High positive genotypic correlation observed for number of fruits/plant and weight of individual fruit with yield/plant is in conformity with the findings of Sachan and Tikka (1971), Choudhary and Mandal (1987), Singh and Singh (1988) and Rajendran and Thamburaj (1993). High genotypic correlation observed in this study between yield/plant and flesh thickness is in agreement with the findings of Rajendran and Thamburaj (1993). Negative genotypic correlation observed between length of vine and yield/plant is in agreement with the findings of Chhonkar et al. (1979), Swamy et al. (1985) and Laltaprasad et al. (1988).

A highly significant positive phenotypic correlation was observed between yield/plant with number of branches/plant, number of fruits/plant, weight of individual fruit, flesh thickness and percentage of germination. A highly significant negative phenotypic correlation was observed between yield/plant with days to first male flower production, node at which first male flower was produced, days to first female flower production, node at which first female flower was produced, internodal length, length of vine, node at which first fruit was produced, rind thickness and days to first harvest. The significant positive phenotypic correlation recorded for yield/plant with number of primary branches/plant is in agreemnt with the findings of Sachan and Tikka (1971) and Swamy et al. (1985). Highly significant phenotypic correlation observed in the present study between yield/plant with number of fruits/plant and weight of individual fruit is in conformity with the findings of Sachan and Tikka (1971), Choudhary and Mandal (1987), Singh and Singh (1988) and Rajendran and Thamburaj (1993). Significant positive phenotypic correlation observed between yield/plant and flesh thickness in the present study is in conformity with the findings of Rajendran and Thamburaj (1993). Singh and Singh (1988) observed that yield has a negative phenotypic correlation with rind thickness, number of days and node number for the appearance of the first female flower which is in conformity with the present findings.

Yield/plant exhibited a significant positive error correlation with number of fruits/plant, weight of individual fruit and flesh thickness. This indicates that all these characters are highly influenced by the environmental factors. Yield/plant also recorded a significant negative error correlation with node at which first male flower was produced.

High positive genotypic correlation and significant positive phenotypic correlation of yield/plant with number of branches/plant, number of fruits/plant, weight of individual fruit and flesh thickness indicate that selection based on any one of the above characters may also result in the improvement of yield in watermelon.

5.4.2 Correlation coeffcient of TSS with other characters

TSS recorded high positive genotypic correlation with days to germinate, number of branches/plant and percentage of germination. TSS also exhibited high negative phenotypic correlation with days to first male flower production, node at which first male flower was produced, days to first female flower production, node at which first female flower was produced, internodal length, length of vine, node at which first fruit was produced and rind thickness. TSS of fruit also recorded positive correlation with yield which is in conformity with the result of Singh and Singh (1988). Sidhu and Brar (1981) reported negative correlation between yield and TSS which could not be confirmed in the present study.

A positive and significant phenotypic correlation was recorded between TSS and other characters viz. number of branches/plant, number of fruits/plant, percentage of germination, number of seeds/fruit and days to germinate. TSS recorded a significant negative phenotypic correlation with days to first male flower production, node at which first male flower was produced, days to first female flower production, node at which first female flower was produced, internodal length, length of vine and node at which first fruit was produced.

Since TSS exhibited a high positive genotypic correlation with, days to germinate, percentage of germination, number of branches/plant, yield/plant and a highly significant positive phenotypic correlation with number of branches/plant, number of fruits/plant and number of seeds/plant, any one of the above characters can be selected for improving the TSS content in fruits. And it also suggested to select the characters viz., number of fruits/plant or yield/plant because an improvement on any of these characters will give an increase in the TSS content too.

5.4.3 Correlation coefficient of earliness with other characters

Days to first fruit harvest is an indication of the duration of the genotype. In the present study, days to first fruit harvest recorded a high positive genotypic correlation with days to first male flower production, node at which first male flower was produced, days to first female flower production, node at which first female flower was produced and node at which first fruit was produced. Earliness also showed a highly negative genotypic correlation with number of fruits/plant and yield/plant. Singh and Singh (1988) and Rajendran and Thamburaj (1993) reported the same findings in watermelon. Days to first female flower production recorded a high positive genotypic correlation with yield in the present study and is in agreement with the findings of Sachan and Tikka (1971).

Earliness also recorded a highly significant positive phenotypic correlation with days to first male flower production, node at which first male flower was produced, days to first female flower production, node at which first female flower was produced, length of vine, node at which first fruit was produced and 100 seed weight. Earliness registered a significant negative phenotypic correlation with number of fruits/plant, yield, weight of individual fruit and number of seeds/fruit. Highly significant phenotypic correlation between earliness and days to first female flower production recorded in the present study is in conformity with the result of Sachan and Tikka (1971). Significant negative phenotypic correlation recorded for earliness with number of fruits/plant and yield is in agreement with the study of Singh and Singh (1988) and Rajendran and Thamburaj (1993).

None of the traits showed significant error correlation with earliness. This indicates that earliness is not influenced by the environmental factors.

From the present investigation, it is revealed that any one of the traits viz. days to first male flower production, node at which first male flower is produced, days to first female flower production, node at which first female flower is produced, length of vine, node at which first fruit is produced and 100 seed weight should be selected inorder to improve the earliness.

5.5. Path analaysis

Yield/plant is influenced by the different components both directly and indirectly. Path analysis is applied to distangle the direct and indirect influence of the component characters of yield. Hence it gives information on the components having direct and indirect contribution towards yield. (Singh and Singh 1988).

The path analysis was done in the present study using node at which first female flower was produced, internodal length, length of vine, number of branches/plant, number of fruits/plant, weight of individual fruit and flesh thickness as causes and yield as the effect. Number of fruits/plant, weight of individual fruit, flesh thickness, number of branches/plant and internodal length showed positive direct effect on yield/plant, whereas node at which first female flower was produced and length of vine, showed negative direct effect. Number of fruits/plant showed maximum direct positive effect on yield/plant followed by weight of individual fruit. Internodal length, number of branches/plant and flesh thickness also had positive but low direct effect. The correlation between the number of fruits/plant and yield/plant was more than its direct effect. This was mainly due to the positive indirect effect exerted through the weight of individual fruit and flesh thickness. This result is in conformity with the findings of Singh and Singh (1988) and Pandita et al. (1990).

Weight of individual fruit was the second component having maximum positive direct effect on yield. The correlation between the weight of individual fruit and yield was observed to be higher than the direct effect. This was mainly due to the positive indirect effect exerted through the number of fruits/plant and the flesh thickness. The positive indirect effect of number of fruits/plant on yield obtained in this study is in conformity with the result obtained by Rajendran and Thamburaj (1993).

Internodal length recorded very low but positive direct effect on yield. However its correlation was found negative. This might be due to the negative indirect effect exerted through number of branches/plant, number of fruits/plant, weight of individual fruit and flesh thickness. Solanki and Shah (1992) reported that internodal length had a positive direct effect on fruit yield. It is confirmed in the present study.

Number of branches/plant recorded positive but very low direct effect on yield. But its correlation was very high. This was due to the positive indirect effect exerted mainly through number of fruits/plant and weight of individual fruit.

Flesh thickness also recorded very low but positive direct effect on yield. Here also the correlation coefficient was high. This was mainly due to the positive indirect effect exerted through the number of fruits/plant and weight of individual fruit.

Node at which first female flower was produced recorded very low but negative direct effect on yield. Here, the correlation coefficient was negative but high. This might be due to the indirect effect exerted through number of fruit/plant and weight of individual fruit. However Sidhu et al. (1981) reported maximum direct positive effect on yield with node at which first female flower was produced.

Length of vine in the present study also recorded very low but negative direct effect on yield. Here also the correlation coefficient was negative but very high. This is mainly due to the indirect effect through the number of fruits/plant and weight of individual fruit. Very low negative direct effect recorded in the present study is not supporting the findings of Gopalakrishnan et al. (1980) who reported maximum direct effect on yield with length of vine in pumpkin.

Based on the result of variable correlation and path analaysis, it can be recommended that selection based on the number of fruits/plant and weight of individual fruits will be effective for the improvment of yield in watermelon.

5.6 Discriminent function analaysis

Discriminent function analaysis is a method of selection of genotypes based on multiple observable characters. This analysis was first developed by Fisher (1936) and later applied by Smith (1936) for making selection on several characters simultaneously. According to Hazel (1943), selection based on suitable selection index is more efficient than selection based on individual characters.

In the present study, selection index was constructed using yield/plant and other variables such as weight of individual fruits, number of fruits/plant, and TSS. Economic weight given for all these characters were in unity. Based on the analysis, genotypes viz. Sugar Baby, Ashai Yamato, HW 1 and Fuken were identified as superior ones for the southern region of Kerala.

From the present study, the following inferences can be made

1. In watermelon, all the characters exhibited significant differences among varieties under Vellayani condition.

2. All the characters under study recorded high heritability.

3. High genetic advance was recorded only for the number of seeds/fruit.

4. Yield/plant exhibited significant positive correlation with number of branches/plant, number of fruits/plant, weight of individual fruits, flesh thickness and percentage of germination.

5. TSS is positively correlated with number of branches/plant, number of fruits/plant, percentage of germination and number of seeds/fruit.

6. Earliness is positively correlated with node and days to first female flower production, length of vine, node at which first fruit is produced, and 100 seed weight.

7. Number of fruits/plant, weight of individual fruit, flesh thickness, number of branches/plant, and internodal length showed positive direct effect on yield.

8. Sugar Baby, Asahi Yamato, HW 1 and Fuken were idnetified as superior ones for the southern region of Kerala.

Since growers give more preference to yield, quality and earliness in watermelon, more weightage should be given for these characters for future breeding programme. All these characters are exhibiting high heritability, so the crop can be improved through selection. Yield is positively correlated with TSS. But yield and quality are negatively correlated with earliness. It is easier to improve yield and quality simultaneously by selecting the positively correlated characters viz. number of branches/plant, weight of individual fruit, number of fruits/plant, percentage of germination and number of seeds/fruit. Most of these characters also showed positive direct effect on yield. In future breeding programme all the above specified characters may be taken in to account, and for quality improvement, combination breeding can be tried.

SUMMARY

SUMMARY

Twenty watermelon genotypes were evaluated in RBD with three replications at the College of Agriculture, Vellayani during 1994-95. The study was conducted to assess the variability in growth, production and quality parameters and to identify the superior types for further improvement programme. The summary of the results are presented hereunder.

The analysis of variance revealed significant differences with respect to all the characters indicating the presence of wide difference between the genotypes tested. High phenotypic and genotypic variance were observed for percentage of germination and number of seeds/fruits. High genotypic and phenotypic coefficients of variation were observed for 100 seed weight, number of fruits/plant, and node at which first female flower was produced. All the characters under study recorded very high heritability estimate and low genetic advance except number of seeds/fruit.

Yield/plant recorded high positive genotypic and phenotypic correlation with number of fruits/plant, number of branches/plant, weight of individual fruit, flesh thickness and percentage of germination. Yield/plant also recorded high negative genotypic correlation with length of vine, node at which first fruit was produced and days to first harvest. A highly

significant negative phenotypic correlation observed on yield with days to first male flower production, node at which first male flower was produced, node at which first female flower was produced, internodal length, length of vine, node at which first fruit was produced, rind thickness and days to first harvest.

TSS recorded a high positive genotypic and phenotypic correlation with percentage of germination and number of branches/plant. A high negative genotypic and phenotypic correlations were observed on TSS with days to first male flower production, node at which first male flower was produced, days to first female flower production, node at which first female flower was produced, internodal length, length of vine and node at which first fruit was produced.

Days to first harvest recorded a high positive genotypic and phenotypic correlation with days to first male flower production, node at which first male flower was produced, days to first female flower production, node at which first female flower was produced, and node at which first fruit was produced. Earliness also exhibited high negative genotypic and phenotypic correlation with number of fruits/plant and yield.

In the present study, yield/plant exhibited a significant positive error correlation with number of fruits/plant, weight of individual fruit and flesh thickness, which indicates that these characters are highly influenced by environmental factors. TSS and earliness recorded a non significant error correlation with other factors.

Number of fruits/plant recorded positive direct effect on yield followed by weight of individual fruit. On the basis of the results of variability, correlation and path analysis it can be concluded that selection based on number of fruits/plant, weight of individual fruit and flesh thickness will be effective for the improvement of yield in watermelon.

A selection index was formulated using the characters viz, yield/plant, number of fruits/plant, weight of individual fruit and TSS. Twenty per cent selection was carried out and four top ranking genotypes viz. Sugar Baby, Asahi Yamato, HW 1 and Fuken were identified. These superior genotypes can be popularised for cultivation in the southern districts and for further breeding programme.

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VARIABILITY STUDIES IN WATERMELON
(*Citrullus lanatus* (Thunb) Mansf.)

By

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ABSTRACT OF THE THESIS
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ABSTRACT

Twenty watermelon genotypes were evaluated in RBD with three replications at College of Agriculture, Vellayani during 1994-95. The study was conducted to assess the variability in growth, production and quality parameters and to identify the superior types for further improvement programme. Data on nineteen characters were collected and subjected to analysis of variance and co-variance. Genetic parameters like heritability, genetic advance and correlations were estimated. The path analysis was done to assess the cause-effect relationship and discriminant function analysis to formulate selection index.

The analysis of variance revealed significant difference with respect to all the characters. High genotypic and phenotypic variances were observed for number of seeds/fruit and percentage of germination. Highest phenotypic and genotypic coefficients of variations were observed for 100 seed weight and weight of fruits/plant indicating the presence of large amount of genetic variability.

High heritability estimates were recorded for all the characters viz. days to germinate, percentage of germination, days to first male flower production, node at which first male flower was produced, days to first female flower production, node

at which first female flower was produced, internodal length, length of vine, node at which first fruit was produced, number of branches/plant, number of fruits/plant, weight of fruits/plants, weight of individual fruit, flesh thickness, rind thickness, TSS, number of seeds/fruit, 100 seed weight and days to first harvest. Number of seeds/fruit only recorded high heritability along with high genetic advance indicating additive gene action.

High positive genotypic correlation and significant positive phenotypic correlation were obtained for yield with number of fruits per plant, weight of individual fruit, flesh thickness and number of branches/plant, TSS with number of branches/plant, percentage of germination and number of fruits/plants, earliness with days to first female flower production, node at which first female flower was produced, node at which first fruit was produced, length of vine and hundred seed weight.

Path coefficient analysis revealed that number of fruits/plant had the maximum direct effect an yield followed by weight of individual fruits. Length of vine recorded negative direct effect on yield.

Based on the result of variability, correlation and path analysis it is suggested that yield, TSS and earliness can not be improved simultaneously. Yield and TSS can be improved by selecting the characters viz. number of fruits/plant, weight of individual fruit, number of branches/plant and percentage of germination.

A selection index was constructed and by practicing twenty per cent selection, genotypes viz. Sugar Baby, Asahi Yamato, HW 1 and Fuken were identified as the superior ones for the southern tracts of Kerala.