EVALUATION OF BOTTLE GOURD [*Lagenaria siceraria* (mol.) standl.] GENOTYPES FOR GROWTH, YIELD AND QUALITY.

by

YOGANANDA M.

(2018-12-028)

THESIS

Submitted in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE IN HORTICULTURE

Faculty of Agriculture

Kerala Agricultural University

DEPARTMENT OF VEGETABLE SCIENCE

COLLEGE OF AGRICULTURE

VELLAYANI, THIRUVANANTHAPURAM - 695 522

KERALA, INDIA

2020

DECLARATION

I, hereby declare that this thesis entitled **"EVALUATION OF BOTTLE GOURD [*Lagenaria siceraria* (mol.) Standl.] GENOTYPES FOR GROWTH, YIELD AND QUALITY"** is a bonafide record of research work done by me during the course of research and 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.

Vellayani **YOGANANDA M**

Date: 19-10-2020 (2018 -12-028)

CERTIFICATE

Certified that this thesis entitled **"EVALUATION OF BOTTLE GOURD [*lagenaria siceraria* (mol.) Standl.] GENOTYPES FOR GROWTH, YIELD AND QUALITY"** is a record of research work done independently by Mr. Yogananda M under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to him.

Place: Vellayani
Date: 19-10-2020

Dr. M. Rafeekher
(Chairman, Advisory Committee)
Assistant Professor and Head
Dept. of Fruit science
College of Agriculture, Vellayani
Thiruvananthapuram 695 522

,

CERTIFICATE

We, the undersigned members of the advisory committee of Mr. Yogananda M., a candidate for the degree of Master of Science in Horticulture, with major in Vegetable Science, agree that the thesis entitled **"EVALUATION OF BOTTLE GOURD [*lagenaria siceraria* (mol.) Standl.] GENOTYPES FOR GROWTH, YIELD AND QUALITY"** may be submitted by Mr. Yogananda M., in partial fulfilment of the requirement for the degree.

Dr. M. Rafeekher
(Chairman, Advisory Committee)
Assistant Professor and Head
Dept. of Fruit science
College of Agriculture, Vellayani
Thiruvananthapuram

Ms. Shruthy O. N.
(Member, Advisory Committee)
Assistant Professor
Dept. of Vegetable Science
College of Agriculture, Vellayani
Thiruvananthapura

Dr. S. Sarada
(Member, Advisory Committee)
Assistant Professor and Head
Department of Vegetable Science
College of Agriculture, Vellayani
Thiruvananthapuram

Dr. Beena Thomas
(Member, Advisory Committee)
Assistant Professor
Dept. of Plant Breeding & Genetics
College of Agriculture, Vellayani
Thiruvananthapuram

ACKNOWLEDGEMENT

"WORK IS WORSHIP"

I feel immense pleasure and privilege to express my sincere gratitude and thankfulness to **Dr. M. Rafeekher, Dr. I. Sreelathakumary***,* ***Dr. S Sarada,*** **Dr. Beena Thomas,** ***Ms. Shruthy O. N.*** *for the guidance and suggestions in the pursuit of the work.*

I express my heartfelt thanks to research scientists, teachers, seniors and friends from THE DIFFERENT PARTS OF ***India, ONE WHO helped during my needy situation.***

A special thanks to LABOURS OF COA, Vellayani *for their* ***"CONDITIONAL HELP"*** *AND co-operation.*

Yogananda M

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDIXES

LIST OF ABBREVIATIONS

ANOVA	:	Analysis of variance
Ca	:	Calcium
CD (0.05)	:	Critical difference at 5 % level
cm	:	Centimetre
d.f.	:	Degrees of freedom
DAS	:	Days after sowing
DAP	:	Days after planting
DAT	:	Days after transplanting
e*t al.*	:	Co-workers/ Co-authors
Fig	:	Figure
FYM	:	Farm yard manure
g	:	Gram
GA	:	Genetic advance
GCV	:	Genotypic coefficient of variation
ha^{-1}	:	Per hectare
IARI	:	Indian Agricultural Research Institute
i.e	:	That is
K	:	Potassium
KAU	:	Kerala Agricultural University
kg	:	Kilogram
m	:	Meter
mm	:	Millimeter
NHB	:	National Horticultural Board
POP	:	Package of practices
RBD	:	Randomized Block Design
RH	:	Relative density
SEm	:	Standard error of mean
viz.	:	Namely

LIST OF SYMBOLS

%	:	Per cent
@	:	at the rate of
ºC	:	Degree Celsius
µ	:	Micro

INTRODUCTION

1. INTRODUCTION

Bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] is an important tropical and sub-tropical cucurbitaceous fruit vegetable known by numerous vernacular names, viz., Madhura - alabu (Sanskrit), calabash gourd (English), Chorakaa (Malayalam), Doodhi, Lauki (Hindi), Halugumbala (Kannada), Suraikai (Tamil), Sora kaya (Telegu) etc. in different parts of India (Deore *et al.*, 2009). It is one of the most important warm-season crops of India and grows best in a warm humid climate. It is a highly appreciated fruit vegetable because of its diverse uses such as food, medicine, containers **(**Jeffrey, 1976).

It is one of the most admired cucurbitaceous fruit crops grown worldwide in the tropical climates of India, Sri Lanka, Indonesia, Malaysia, Philippines, China, Iraq, Turkey, Dominican Republic, Haiti, Hawaii, Venezuela, as well as in most parts of Africa, Europe and South America (Salunkhe and Kadam, 1998; Nicola *et al*., 1999).

Bottle gourd is native to Africa and it occurs as a wild form in South Africa and India. However, the largest variability among *Lagenaria spp*. is reported from India. Most fascinating variability is recorded in its fruit shape and size. The genus *Lagenaria* was earlier considered to be monotypic in nature but now has total of six species, out of which only *L. siceraria* is domesticated monoecious annual while other five are wild, perennial and dioecious in nature. This species appears to have been domesticated independently in Asia, Africa, and the New World.

India had a rich source of bottle gourd germplasm, with a collection of 1,814 accessions (Anjula *et al.*, 2019) from different places of Uttar Pradesh (219), Andhra Pradesh (145), Uttarakhand (122), Gujarat (91) and Jammu and Kashmir (73). Few pieces of literature point out that wild races are still found in Dehradun (high humid area) and Malabar coastal areas and considered as the centre of origin for bottle gourd. In India, bottle gourd occupies an area of 157 thousand hectares with an annual production of about of 2683 thousand metric tonnes during the year 2017-2018 (NHB, 2018) and is mostly grown in the states of Uttar Pradesh, Madhya Pradesh, Bihar, Haryana, Chhattisgarh, Odisha, Jammu and Kashmir, Punjab, Tamil Nadu, Karnataka, Maharashtra, Andhra Pradesh and Kerala. Bottle gourd plants are day-neutral, grown as summer and rainy season crop.

Bottle gourd is a vigorous annual day neutral climbing vine with hairy stems, long forked tendrils and cordate leaves The flowers are solitary and strictly cross pollinated due to its monoecious nature, where in bears more male flowers and less female flowers are borne separately on the same plant. Many forms of the bottle gourd have been cultivated for specific purposes and high genetic diversity for fruit shape (round, club, pear, long, cylindrical etc.) and other fruit traits resulted in a variety of uses in daily human life.

Bottle gourd forms an excellent diet being rich in vitamins, iron, and minerals. Its fruit juice helps to regulate blood pressure of hypertensive patients, because of its high potassium content, relieves constipation, prevent the prematurely greying hair, urinary disorders, and insomnia (Ghule *et al.,* 2007). Extract of the bottle gourd seeds is a potential source of protein, lipid, macro and micronutrients. The chemical compound 'lagenina,' is available in the lyophilized water extract of seeds. It is a novel ribosome disabling protein hence possesses properties like immunosuppressive, antiviral, antitumor, antiproliferative, and anti-HIV activities (Wang and Ng, 2000; Kubde *et al.*, 2010). The leaves in the form of decoction with sugar are used for curing jaundice.

Cultivation of bottle gourd in Kerala covers 1.16 thousand hectares area and 13.52 thousand metric tonnes production with the productivity of 11.65 MT/ha which is very low when compared to the national average productivity of 17.08 MT/ha (NHB, 2018). There is more demand for long shaped bottle gourd fruits throughout the year and Arka Bahar is the recommended variety for cultivation in Kerala (KAU, 2016).

The climatic condition of Kerala is well suited to bottle gourd cultivation where tropical humid climate ensures good yield and the bottle gourd crop can be raised in kharif, summer season and even in winter. Due to short duration nature, bottle gourd can fit well to the multi-cropping system of Kerala and fetch maximum price due to good export potential. Bottle gourd serves as a rootstock in watermelon breeding to control soil-borne diseases and to manage low soil temperature stress (Lee, 1994; Yetisir and Sari, 2003). Being fairly resistant to biotic and abiotic stresses, the crop can be made fit into organic production systems but adaptability and performance of different genotypes of bottle gourd have not been documented in Kerala and wide variation exists in different horticultural traits among the genotypes of bottle gourd.

A number of superior bottle gourd hybrids and varieties have been developed and grown in different regions of India. Development of an early maturing and high yielding, long type variety will be helpful for increasing the productivity and export. Collection and evaluation of germplasm is a prerequisite for their utilization and a detailed evaluation determines the potential of cultivar in the specific crop improvement programme.

Hence the present investigation was taken up with the objectives

1. To evaluate long type bottle gourd accessions/genotypes for growth, yield and quality under Kerala conditions
2. To assess the genetic variability present in long type bottle gourd genotypes and finding potential cultivar for Kerala.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] is an important tropical and sub-tropical cucurbitaceous vegetable grown worldwide for its diverse uses such as food, medicine and suitable for container growing. The crop improvement of bottle gourd was begun 1970's, when first public sector F_1 hybrid Pusa Meghdoot was developed. Bottle gourd varieties and hybrids varied significantly for different horticultural traits under same growing environment.

The productivity of any breeding work primarily stood upon the choice of parental material. While choosing the parental genotypes, the mean performance of genotypes is a primary consideration, among the breeders for a long time. In this context, systematic evaluation of accessions and varieties with different horticultural traits under different geographical regions is vital to explore the prospects of popularizing the superior genotypes under cultivation. In this chapter, an effort has been made to review the available literature concerning the evaluation of varieties and hybrids in bottle gourd and other cucurbitaceous fruit vegetables for growth, yield, and quality traits.

The review is presented under the following sections:

2.1 GROWTH PARAMETERS

2.1.1 Vegetative Characters

2.1.1.1 Plant Height (cm)

Rabbani *et al.* (2012) evaluated 60 accessions of ridge gourd collected from different locations of Bangladesh for variability and genetic diversity. Study revealed that vine length of ridge gourd varied from 2.35 (cm) to 9.55 (cm).

Sharma *et al*. (2016) study revealed that trailing method had significantly higher vine length (4.56 m) at 55 DAS over traditional method.

Ten genotypes of bottle gourd were collected for genetic variability study by Vaishali (2016) and found that maximum vine length noted in genotype 2013/BOG VAR-1 (429.13cm) and the minimum vine length in BBOG 15-3 (29.62cm).

2.1.1.2 Number of Branches Vine^{-1}

Gichimu *et al.* (2008) reported that the maximum number of branches per vine was 11.0 in Kakamega landrace and Crimson Sweet (5) cultivars of watermelon.

Sureshkumara *et al.* (2017) conducted the experiment to study the performance of 24 bitter gourd hybrids at UAS, Bengaluru. Result revealed that branches per vine in parents ranged from 7.09 (Green Long) to 10.30 (Chidambaram Small) and the standard check had 9.00 mean number of primary branches compared to F_1 hybrids that exhibited mean number of primary branches ranging from 7.56 to 12.30. A study on genetic improvement of yield and fruit traits in snake cucumber recorded that number of branches plant^{-1} was significantly increased by individual plant selection in AS_2 (3.40), AS_3 (2.77) and DK_1 (2.63) compared to their original populations Abed (2018).

2.1.1.3 Number of Leaves Vine^{-1} at Monthly Interval

The variety Shivani selection recorded maximum number of leaves per vine (50.17 and 167.77 at 30 and 60 DAS respectively) and minimum was noted in Pusa Naveen (20.4 leaves at 30 DAS) and Bottle gourd -111 (112.7 leaves at 60 DAS) Vittal (2016).

2.1.1.4 Inter Nodal Length (cm)

Sharma and Sengupta (2013) conducted genetic diversity analysis with 16 genotypes of bottle gourd and internodal length of variety Narendra Jyoti was highest (15.26 cm) followed by Ketan (14.17 cm) and Narendra Shishir-1 (14.08 cm).

Among the six landraces of ridge gourd, the accession AHRG-27 had the lowest internodal length of 12.87 cm followed by AHRG 29 (14.09), AHRG-31 (15.03), AHRG-33 (15.27 cm), AHRG-41 (16.06 cm) AHRG-47 (17.17 cm) Choudhary *et al*. (2014).

2.1.2 Flowering Parameters

2.1.2.1 Days to First Male Flower

Singh and Singh (2014) conducted evaluation trial of eight bottle gourd accessions Damini, Prasad (NBGH-4000), Anmol, Anokhi, Virat (NBGH-168), US-15, Local round, Local long. Among all varieties Virat (NBGH168) was best in terms of DFMF (days to first male flower) anthesis (43.09).

Twenty - seven genotypes of bottle gourd were studied to check variability in flowering behaviour. Analysis of variance revealed that highly significant differences among genotypes for first male flower opening that ranged from 50.30 days to 82.00 days Tirumalesh *et al.* (2016).

Sultana *et al.* (2018) studied the genetic variability, correlation and path co-efficient analysis in 39 bottle gourd accessions and result revealed that days to first male flower opening ranged from 45.80 to 59.67 days.

2.1.2.2 Number of Node of Appearance of First Male Flower

Samadia (2007) noticed difference in node to first male flower that ranged from 2.24 (DPY-125) to 4.0 (PDVR-48) in a field trail which encompassed of 18 accessions of round melon. The node number to first male flower initiation varies from 5.67 to 13.20 among twenty-seven bottle gourd genotypes Tirumalesh *et al.* (2016).

Bottle gourd genotypes LS-3 produced lowest node to first male flowering (10.24) followed by LS-10 (11.84) node among 20 accessions of bottle gourd Kandasamy *et al.* (2019).

2.1.2.3 Days to First Female Flower

Singh and Singh (2014) conducted an evaluation trial of eight bottle gourd genotypes viz., NBGH-4000, Anmol, Anokhi, Virat, US-15, Local Round, and Local Long. Among varieties Virat was the earliest in terms of days to first female flower opening (44.21).

Karthik *et al*. (2017) studied genetic variability with 14 advanced inbred accessions of ridge gourd at ICAR-IIHR, Bengaluru and the result revealed that inbred accession RG-27 was earliest to first female flower anthesis (41.28 DAT) and the genotype RV-1 was late (56.17 DAT). The cultivar Chandra long special took minimum days to first female flower anthesis (47 days) among the 18 genotypes of bottle gourd studied by Rana *et al*. (2018).

Tadkal *et al.* (2019) studied 13 genotypes of ash gourd for different horticultural traits and noted that G-2 was earliest to first female flower opening (61.8) followed by G-4 (61.9), G-3 (62.2) and G-7 (71.3) was late to first female flower opening.

2.1.2.4 Number of Node of Appearance of First Female Flower

Among the 27 bottle gourd genotypes, the trait node number to first female flower appearance varied significantly that ranged from 7.80th node to 14.87th node Tirumalesh *et al.* (2016).

The genotype LS-3 produced first female flower at 14th node being the lowest among 20 genotypes which were collected from different parts of Tamil Nadu for field experiment to access genetic variability Kandasamy *et al.* (2019).

2.1.2.5 Number of Male Flowers

Hamid *et al*. (2002) studied six *Cucumis sativus* genotypes for different horticultural traits, result revealed that among the accessions maximum percent of male flowers were observed in cultivar Ashly (14.0 %) while minimum in cultivar Swat local (8.66 %).

A field experiment was conducted at the Department of vegetable crops, Tamil Nadu Agricultural University, Coimbatore to find out the effect of training and pinching on flowering traits of bottle gourd cultivar $CBgH_1$. Among the treatments, pinching on secondary laterals at 6th node was proved to be superior in respect to flowering traits with the highest total number of female flowers per plant (20.6) as recorded by Ciba and Syamala (2017).

2.1.2.6 Number of Female Flowers

Hidayatullah *et al.* (2012) studied the effect of plant growth regulators on sex expression of bottle gourd plants and the result revealed that gibberellic acid and maleic hydrazide significantly improved the number of female flowers per plant as compared to control and ethylene treatments. Maximum number of female flowers plant^{-1} (24.9) were recorded with gibberellic acid at 30 µmol L^{-1} followed by gibberellic acid at 15 µmol L^{-1} as compared to control (10.2) female flower.

Different varieties of bottle gourd were studied in different cultivation systems and found that more female flower per plant (33.79) in trailing system (S_1), while a minimum number of female flowers (29.89) was noted in the ground trailing system (S_2) Shinde *et al* (2014).

2.1.2.7 Sex Ratio (M/F)

Harika *et al*. (2012) study revealed that the sex ratio (M/F) ranged from 12.62:1 in Gaja and 24.4:1 in Anand bottle gourd-1.

A study on variability in flowering behaviour twenty-seven genotypes in bottle gourd, was done by Tirumalesh *et al.* (2016) and found the sex ratio being ranged from 4.73:1 to 14.87:1.

Buthelezi *et al.* (2019) studied morphological variation in *Lagenaria siceraria* landraces, and found that the sex ratio ranged from 0.4 to 1.6 with a mean of 1.1.

2.1.3 Fruit Yield Parameters

2.1.3 .1 Node to First Fruit Initiation

Ahsan *et al.* (2014) conducted field experiment at the experimental farm of BSMRAU, Gazipur to study the performance of seven parents and 12 F_1 hybrids of snake gourds for genetic variability. Analysis of variance for the trait, node to first fruit showed significant differences among the parents. The lowest number of nodes for first fruit was observed in SG-10 (13.66^{th}) and highest in SG-06 (23.33^{th}). The lowest number of nodes for first fruit was recorded in the hybrid cross between SG-10 × SG-25 (14.66^{th}) node and the highest in hybrid cross between SG-01 × SG-26 (23^{th})**.**

2.1.3 .2 Fruit Set (%)

Evaluation of 10 sponge gourd genotypes was done by Phan *et al.* (2015) during summer-autumn season and found that percent fruit setting ranged from 16 percent in genotype QN to 45.17 percent in genotype B-29. Thakur *et al*. (2015a) conducted a field experiment to study the genetic divergence with 22 bottle gourd accessions at IGKV, Raipur and among accessions, the genotype 2010-BOG-VAR-3 exhibited early fruit setting 31.93 (DAT).

The overall mean performance of bottle gourd genotypes for fruit set was ranged from 55.00 percent to 84.30 percent and maximum fruit set percentage was noted in Shivani selection (84.30 %) and minimum fruit set percentage noted in Bottle gourd-111 (55.00%) Vittal (2016).

Patle *et al.* (2018) conducted a field experiment on integrated nutrient management (INM) in bottle gourd at Dr. PDKV, Akola. The result revealed that the fruit set percent was noted highest for the treatment T_{12} (75.11%) and the lowest in treatment T_{13} (48.25%).

2.1.3 .3 Days to First Harvest

Evaluation trial of eight bottle gourd genotypes was done by Singh and Singh (2014) and found that the genotype Local round took maximum of 69.06 days for first fruit harvest and minimum in Virat (51.14).

Rathore *et al.* (2017) conducted field experimental at SHIATS, Allahabad with 12 accessions of ridge gourd for different horticultural traits and accessions RIGVAR-1 took least number of days (45.13 days) while RIGVAR-5 took 56 days to first harvest.

Som (2018) conducted a field study on variability in ridge gourd and found that genotype 2016-SPGVAR-1 took 82.33 days for first fruit harvest followed by Pusa Chikni (83.06), 2016-SPGVAR-6 (83.53) and genotype 2016-SPGVAR-2 took 88 days.

2.1.3 .4 Fruit Skin Colour

Bottle gourd variability studies by many researchers reveals that fruit colour varies from dark green to cream or yellow Heiser (1979), Rahman *et al*. (1986) and Pandit *et al.* (2009).

Mashilo *et al*. (2017a) studied 36 land races of bottle gourd for different horticulture traits. Among the landraces primary fruit colour for 23 landraces was dark green, nine landraces had light-green colour and four landraces had medium green colour.

About 37 public sector bottle gourd accessions were collected for variability and morphological characterization study by Panigrahi and Duhan (2018) and found 16 accessions had light green colour, 14 accessions had green, five had dark green and two mottle green.

2.1.3 .5 Fruit shape

Morimoto *et al.* (2005) studied diversity analysis of bottle gourd landraces and its wild relatives at Kenya and the study revealed that the bottle gourd verities exhibited high variation in fruit shapes like oblate, spherical, ovoid and pear.

From Mediterranean region of Turkey bottle gourd germplasm were collected for morphological characterization by Yetisir *et al.* (2008) and found that the fruit shape varied differently from globular to spindle elongated and some of the accession had necks with various shapes.

2.1.3 .6 Fruit Length (cm)

Sivaraj and Pandravada (2005) studied morphological diversity in bottle gourd germplasm collected from different tribal areas of Telangana. The trait fruit length varied significantly by ranging from 13.3 to 83.9 (cm) and among the accessions IC-249164 had maximum fruit length (83.9 cm).

About fifteen accessions of bottle gourd were evaluated for different morphological, yield, and fruit yield traits by Mahato *et al.* (2010) and found that significant variation existed for fruit length (10.42 to 42.33 cm). Kumar and Prasad (2011) accessed five hybrids and one variety of bottle gourd. Among all the hybrids, Vikrant was found to be superiority in fruit length.

The cultivar Elina exhibited lowest fruit length (9.18 cm) and Anand bottle gourd -1 had longest fruit length (58.92 cm) among the 25 genotypes of bottle gourd studied by Harika *et al.* (2012). Kalyanrao *et al*. (2016) studied genetic diversity in 15 commercial bottle gourd cultivars and Pusa summer prolific long had the highest fruit length (83.61 cm) and the lowest in Pusa Sandesh (14.29 cm).

2.1.3 .7 Fruit Diameter (cm)

Performance studies on oriental pickling melon genotypes was done by Ganiger *et al*. (2014) found highest fruit diameter was noted in genotype BCMCO-04 (14.96 cm). Manu (2014) studied genetic variability in 24 accessions of oriental pickling melon and where in BMSCO-1 had lowest fruit diameter (7.39 cm) and Sirsi-2-13 had highest (13.17 cm).

The fruit diameter of bottle gourd genotypes were ranged from 21.97 to 43.97 (cm) with an average value of 28.90 (cm) and maximum fruit diameter was noted in F_1

hybrid All-rounder (43.97 cm) and minimum was noted in Bottle gourd-112 (21.97 cm) Vittal (2016).

Kunjam *et al.* (2019) studied different quantitative traits in nine bottle gourd genotypes, and maximum fruit girth was noted in genotype 2016-B06VAR-8 (31.86 cm) and lowest fruit girth in Pusa Naveen variety (27.80 cm). However, significantly minimum fruit girth was recorded in 2016-B06VAR-4 (23.73 cm).

2.1.3 .8 Rind Thickness (mm)

Evaluation of twenty-one landraces of sponge gourd was done by Joshi *et al.* (2005) to find fruit thickness ranging from 2.01 to 3.61 (mm) and cultivar Seto Bose had the thickest (2.01 mm) and Jhimni had thinnest skin (3.61 mm). Koppad *et al.* (2015) studied variability and character association in ridge gourd with reference to yield attributes and found that rind thickness was maximum in Arabhavi local (2.28 mm) and minimum in rind thickness was noted in Srinivasapura local (1.38 mm).

The Bottle gourd cultivar Shivani Selection had thickest rind 2.34 cm and cultivar Bottle gourd- 110 had lowest of 1.05 cm rind thickness Vittal (2016).

2.1.3 .9 Flesh Thickness (cm)

Erdinc *et al.* (2008) compared local and improved melon cultivars for their growth and found that F_1 hybrids Rambo and Makdimon had the highest flesh thickness of 29.32 and 28.37 (mm) respectively in the first season and 34.81 mm and 30.82 mm, respectively in the second season.

Twenty-five genotypes of bottle gourd were evaluated for various horticultural traits and Thar Samridhi had the maximum fruit diameter of 160.13 mm among them while cultivar Kaveri recorded the least diameter (59 mm). The difference in flesh thickness could be attributed to inherent characteristics of variety. Fruit flesh thickness increased with increase in size of the fruit i.e., more thick flesh was observed in bigger sized fruits and less in small fruits (Harika *et al.*, 2012).

Tyagraj *et al.* (2014) evaluated twenty-five oriental pickling melon hybrids for various traits and observed that the flesh thickness was ranged from 1.73 to 3.81 cm.

2.1.3 .10 Fruit Weight (g)

The performance of F_6 progenies, derived from the cross between IVMM-3 x Punjab Sunheri of muskmelon exhibited wide range of variability for fruit weight and mean ranged from 642.35 to 892.12 (gram) (Gaikwad, 2016).

2.1.3 .11 Number of Fruits per Vine

Twenty-four genotypes of bottle gourd (standard local cultivars, accessions, F_1 hybrids and F_2 segregants) was evaluated by Samadia (2002) for yield and found that segregates of cross combination between $P_1 \times P_4$ and $P_1 \times P_2$ in F_2 generation. The F1 hybrid of $P_1 \times P_4$ cross and open-pollinated cultivar Pusa Naveen had potential for early harvest, more number of fruits and yield under extremes of hot arid climate. In these genotypes, number of fruits were 8.55, 7.06, 8.02 and 6.37 respectively.

Kamal *et al.* (2012) studied variability in 10 diverse bottle gourd accessions and the number of fruits per vine varied from 3.25 to 9.25. Different varieties of bottle gourd was studied by Shinde *et al.* (2014) and reported that highest number of fruits per vine (10.8). Thakur *et al.* (2015b) conducted a field study with 22 accessions of bottle gourd at IGKV, Raipur, and found that the accession NDBG 104 had highest number fruits per vine (14.8).

Sharma *et al.* (2019) conducted an experiment at 22 farmer fields at Mohali with three bottle gourd genotypes and Punjab Barkat was produced maximum number of fruits vine^{-1} (12).

2.1.3.12 Yield Plant^{-1}(kg)

Kamal *et al.* (2012) studied variability in 10 diverse bottle gourd accessions and the fruit yield vine^{-1} ranged from 1.77 kg to 10.21 kg. Tamil *et al*. (2012) studied 15 pumpkin accession for different horticultural traits and the accession CM-6 recorded the highest mean fruit yield of 11.11 kg vine^{-1} followed by CM-15 (8.56 kg), CM-10 (10.11 kg) and CM-9 (9.50 kg).

Yadav and Kumar (2012) in a study revealed that Pusa summer prolific long followed by VRBG-88 VRBG-105 gave maximum yield per plant among 15 parents.

Sixteen genotypes of bottle gourd were accessed for genetic diversity analysis by Sharma and Sengupta (2013) and found that cultivar Narendra shivani had highest yield of 16.35 kg plant^{-1} followed by NS-421 (12.49 kg), Narendra Sankar Lauki (12.37 kg) and Narendra Shishir (12.26 kg).

Sixty-nine diverse genotypes of bottle gourd were accessed by Sahu (2016) and found that the genotype IBG-61 had highest yield plant^{-1}.

2.1.3.13 Yield Plot^{-1} (kg)

The performance of 16 genotypes of bottle gourd was evaluated by Sharma *et al.* (2019) and found significant higher yield in cultivar Narendra Shivani (311.53 q/ha).

Sahu *et al.* (2014) evaluated eight bottle gourd genotypes and found maximum fruit yield of 592.90 q ha^{-1} in Anokhi and minimum yield of 351.08 q ha^{-1} in variety BGPL-4.

The genetic parameter between yield and yield contributing characters of different bottle gourd genotypes was studied by Visen *et al.* (2014) and found that highest fruit yield of 536.66 q ha^{-1} was noted in IBG-11 followed by 226.66 q ha^{-1} in IBG 25 and 223.26 q ha^{-1} in IBG 14.

Resmi and Sreelathakumary (2015) studied genetic variability of bitter gourd accessions and MC-20 had highest fruit yield followed by MC-26, MC-10, MC-22 and MC-27.

At CCS Haryana Agricultural University, Hissar a field experiment was conducted by Kumar and Kumar (2018) in split plot design by keeping plant spacing and nitrogen in main plots and varieties as sub-plots comprising 16 treatment combinations in total viz., two plant spacing, i.e., 60 cm (P_1) and 75 cm (P_2), four nitrogen levels i.e., 50 kg ha^{-1} (N_1), 62.5 kg ha^{-1} (N_2), 75 kg ha^{-1} (N_3) and 87.5 kg ha^{-1} (N_4) and two cultivars i.e., GH-22 (V_1) and HBGH-35 (V_2). The highest fruit yield of 378.0 q ha^{-1} was obtained in treatment T_{15} sown at 60 cm spacing received 87.5 kg nitrogen ha^{-1} over total fruit yield of treatment T_{13} (360.5 q ha^{-1}) in bottle gourd crop.

2.1.3.14 Duration of Crop (days)

An experiment was conducted with 30 ash gourd genotypes at IGKV, Raipur. Among 30 genotypes, minimum crop duration in 133 was noted in IAG 15 and the maximum crop duration of 146.33 days in IAG 23 (Sahu *et al*, 2015).

Thakur *et al*. (2015b) conducted a field study in bottle gourd with 22 accessions at IGKV, Raipur. Among them, maximum crop duration in 2012-BOG VAR 1 (126.6 days) and minimum crop duration in 2011-BOG VAR 3 (100.3 days).

Nine bottle gourd genotypes were evaluated for different quantitative traits by Kunjam *et al*. (2019) at Indira Gandhi Krishi Vishwavidyalaya, Raipur and found that duration of bottle gourd crop ranged from 120.6 to 143.0 (days).

2.1.4 Biochemical Parameters

2.1.2.1 T.S.S. (^{0}Brix)

Phan *et al.* (2015) evaluated ten sponge gourd accessions in summer-autumn season at Thua Thien Hue. Result revealed that TSS value ranged from 2.1 in B-30 to 3.3 in B-29. Bairwa (2016) studied genetic divergence analysis in indigenous germplasm of ash gourd and the result revealed that total soluble solid (TSS) ranged from 2.06 % to 2.67 % with an overall mean of 2.36 %.

The evaluation of bottle guard genotypes at Peshawar valley was done by Ilyas *et al*. (2017) and found that maximum TSS of 1.49 was noted in NS 550 F1 genotype followed by variety Mahraya (1.13) while minimum was recorded in Globe cultivar (0.96).

4.1.4.2 Ascorbic Acid Content of the Pulp (mg/100g)

Iqbal *et al.* (2019) evaluated nine exotic bottle gourd accessions for their fruit biochemical characteristics, the results revealed that ascorbic acid (vitamin-C) contents in different exotic genotypes showed noteworthy differences. The cultivar Anmol had the higher ascorbic acid contents of 16.1 mg/100g and minimum in the cultivar Hazarvi (13.3 mg/100g).

2.1.4.3 Dry Matter Content (%)

The dry matter content in different gourd cultivars was studied by Chandanshive (2003) and found that the dry matter content ranged from 3.91 to 8.10 per cent. Alam *et al.* (2006) conducted variability study with 17 pointed gourd accessions and found that accession TD-04 had highest dry matter (8.51%).

2.1.4.4 Crude Fibre Content (g/100g)

The crude fibre content in different gourd cultivars was studied by Chandanshive (2003) and found that the crude fibre content ranged from 10.2 per cent in MC-84 cultivar of bitter gourd to 33.4 per cent in CHSG-1 of sponge gourd.

Bello *et al.* (2014) studied characterized gourd fruits for dietary values and anti-nutrient constituents. The result revealed that the gourd fruits contain high levels of fibre ranging from the 12.6 g/100g in cucumber to 33.9 g/100g in oriental gourd.

2.1.4.5 Potassium content of the Pulp (mg/100 g)

The biochemical content of fresh bottle gourd pulp was studied by Parle and Kaur (2011) and found that Potassium content was 3320.0 mg/100g.

Gajera (2017) studied processing potential of bottle gourd fruits and result revealed that potassium content of bottle gourd fruit with peel and without peel was 3320 mg/100g and 3356.67 mg/100g respectively.

2.1.4.6 Calcium **content o***f the Pulp (mg/100 g)*

Sithole *et al.* (2015) assessed minerals and protein contents in selected South African bottle gourd landraces and found that both landraces and hybrids contained high amounts of calcium (3108 mg/100g).

2.2. Pumpkin beetle incidence (*Aulacophora foveicollis*)

Bhowmik and Saha (2017) studied the pest complex of bottle gourd in the gangetic plains of West Bengal and results revealed that the red pumpkin beetle adults appeared in the middle of September, and reached the peak during end of October to mid – November and gradually disappeared at the middle of December. The number of adult beetles during this time varied from 6.7 to 9.9 per 0.5 m quadrates causing the significant amount of leaf damage between 6.2 to 35.6 %.

2.3 COEFFICIENT OF VARIATION

Twenty eight bottle gourd accessions were studied by Mathew *et al*. (2000) and recorded the maximum genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) for number of fruits per vine and the lowest for internodal length. Singh and Kumar (2002) studied genetic variability (GV) in bottle gourd genotypes and recorded higher phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV) and heritability for fruit yield per plant, vine length, number of days to first harvest, number of nodes to first male and female flowers, number of primary branches per vine, and fruit length, weight and diameter.

Highest GCV and PCV was reported for yield per vine in bottle gourd genotypes by Singh *et al.* (2008). Mandal *et al.* (2015) studied genetic variability and trait inter-relationship in bottle gourd genotypes revealing high genotypic coefficients of variation (GCV) and phenotypic coefficients of variation (PCV) for sex ratio, fruit length, fruit girth, and number of fruits per vine and fruit yield per vine.

Forty-nine bottle gourd varieties were studied for genetic variability, heritability and genetic advance by Damor *et al*. (2016) and found considerable genotypic variation for 16 different traits. Phenotypic coefficient of variation (PCV) was more than genetic coefficient of variation (GCV) for all traits.

Rambabu *et al*. (2017) studied morphological characterization and genetic variability in bottle gourd and results revealed high magnitude of GCV as well as PCV for traits viz., fruit length (38.07 and 40.34), fruit width (37.11 and 37.92), vine length (30.26 and 30.85), fruit yield per plant (25.50 and 26.00), sex ratio (23.16 and 23.96), number of fruits per plant (22.39 and 23.23), number of primary branches (21.78 and 22.71), seed number per fruit (20.85 and 21.23) and average fruit weight (20.57 and 21.04). Moderate GCV and PCV were recorded for TSS of the pulp (14.12 and 15.21), 100 seed weight (13.70 and 13.87), total sugar content of the pulp (13.35 and 13.75), Ascorbic acid content of the pulp (12.55 and 12.64), days to first harvest (11.57 and 11.94), days to first male flower appearance (10.69 and 10.98) and days to first female flower appearance (10.44 and 10.77).

Thirty-seven bottle gourd genotypes were tested for variability by Panigrahi and Duhan (2018) and found that higher estimates of GCV and PCV for fruit diameter, length of fruit, number of fruits per vine, number of primary branches, nodes to first male flower, and fruit yield per vine.

2.4 HERITABILITY AND GENETIC ADVANCE

Narayan *et al.* (1996) studied on genetic advance, correlation and path coefficient analysis with 25 varied populations of bottle gourd. Wide range of variation was observed in most of the traits.

High heritability and genetic advance (GA) were reported by Prasad *et al.* (2004) in muskmelon for days to first female flower appearance, number of male and female flower per plant, node to male flower and yields plot^{-1}.

Pandit *et al.* (2008) conducted field experiment with 15 genotypes of bottle gourd during the autumn-winter season. There was considerable variability in all traits except fruits per vine and moderate genetic coefficient of variation (GCV) and genetic advance (GA) in fruit length and fruit weight.

Analysis of variance revealed high heritability values for chlorophyll content (97.0), number of branches (90.0), vine length (88.0) and number of leaves (79.0) in ridge gourd (Koppad *et al.*, 2015).

Phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV), heritability and genetic advance (GA) in 24 bottle gourd genotypes were studied by Deepthi *et al.* (2016) for yield and yield components and found magnitude of heritability ranging from 19.14 to 97.39.

High heritability of more than 60 per cent and high genetic advance (GA) for node number of first male flower, node number of first female flower, fruit length, fruit diameter etc. were reported in field study of oriental pickling melon genotypes (Babu and Rao, 2018).

2.5 CORRELATION STUDIES

Umamaheswarappa *et al.* (2004) conducted correlation study in bottle gourd genotypes and found that fruit yield per hectare had strong positive association with vine length, number of female flowers per plant, number of branches per plant, total dry weight of plant, number of fruits per plant, fruit traits.

Genetic diversity, correlation and path co-efficient analysis in bottle gourd genotypes was conducted by Husna (2009) and found that weight per fruit had the positive direct effect (0.453) on yield. This trait also showed positive indirect effect through number of fruits per plant (0.322), fruit breadth (0.008) and fruit length (0.007).

Husna *et al*. (2011) assessed variability, correlation and path analysis for different traits of 31 bottle gourd accessions. The result revealed that highest significant association of yield per vine with reproductive characters like number of fruits per vine followed by fruit weight at genotypic and phenotypic level.

Field experiment was conducted by Raut *et al* (2013) in bottle gourd to study the correlation between yield and its component traits at ZARS, J. N. K. V. V. and reported that correlation coefficient of fruit yield per plant were significantly positive with days to appearance of first male flower (0.117), number of male flower per vine (0.192), number of female flower per plant (0.405), fruit setting percentage (0.475), length of fruit (0.369), weight of fruit (0.157) and number of fruits per plant (0.766).

Sunil *et al* (2014) studied diversity analysis in 20 genotypes of bottle gourd. The results revealed significant negative correlation for intermodal length with peduncle length (-0.44).

An investigation was carried out with 44 genotypes of bottle gourd by Varpe *et al.* (2014) for analysis of correlation coefficient and path coefficients during summer season (2010). Correlation figured between fruit yield and its components indicated a positive and significant correlation of fruit yield with primary branches per vine, fruit length, number of fruits per vine and total sugar content.

Janaranjani and Kanthaswamy (2015) conducted experiment for 18 traits in bottle gourd comprising 36 hybrids obtained by crossing 9 lines and 4 tester by line x tester method to study the correlation and direct and indirect effects of different traits on fruit yield. Overall analysis revealed that fruit yield was positively and significantly associated with fruit flesh thickness, number of fruits per vine and number of fruit pickings.

Ninety-one bottle gourd genotypes were collected by Mahapatra (2017) for genetic diversity analysis using morphological and molecular markers. The results revealed that yield per plant was found to be positive and significant associated with average fruit weight (0.720), number of fruits per plant (0.661) and fruit diameter (0.319).

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The present investigation entitled "Evaluation of bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] genotypes for growth, yield and quality" was carried out at the Department of Vegetable Science, College of Agriculture, Vellayani, during 2019-2020. The study aims to characterize and evaluate long type bottle gourd genotypes in order to identify potential cultivar for Kerala.

3.1 EXPERIMENTAL SITE

The experiment was conducted at experimental plot was located at 8.25 North latitude and 76.59 East longitude, at an altitude of 13 m above mean sea level.

3.1.1 Soil

Predominant soil type of experimental site was red loam belonging to Vellayani series, texturally classified as sandy clay loam.

3.1.2 Climate and weather condition

Thiruvananthapuram is located between 8.17° N 76.41° E and 8.54° N 77.17° E and on an altitude of 10 meters above the mean sea level. The climate of region is warm humid tropical climate. The summers here have a good deal of rainfall, while the winters have very little. The meteorological parameter during the crop season such as minimum and maximum temperature, sunshine hours, rainfall number of rainy days and relative humidity were documented at meteorological observatory presented in Appendix I.

3.2 MATERIALS

The experimental material for this study consist of thirty-one long type bottle gourd genotypes collected from various geographical regions of India. The list of the long type bottle gourd varieties and their source of origin is given in Table 1.

Table 1: Details of Genotypes used in study

Treatment No	Accessions / Genotypes	Source of collection
T_1	Arka Bahar	IIHR, Bangalore
T_2	Pusa Naveen	IARI, New Delhi
T_3	Pant lauki-1	GBPUAT, Uttarakhand
T_4	Pant lauki-4	GBPUAT, Uttarakhand
T_5	Samrat	BSKV, Dapoli
T_6	BG-12	SKUAST, Kashmir, Srinagar.
T_7	KAR -1	Doddagatta, Karnataka.
T_8	BG-8	SKUAST, Kashmir, Srinagar.
T_9	BG-11	SKUAST, Kashmir, Srinagar.
T_{10}	IC146312	NBPGR, New Delhi
T_{11}	Tvpm Local	Thiruvananthapuram Local
T_{12}	IC 334300	NBPGR, New Delhi.
T_{13}	IC284891	NBPGR, New Delhi.
T_{14}	IC284895	NBPGR, New Delhi.
T_{15}	IC311135	NBPGR, New Delhi.
T_{16}	IC339196	NBPGR, New Delhi.
T_{17}	IC 331101	NBPGR, New Delhi.
T_{18}	IC 371745	NBPGR, New Delhi.
T_{19}	BG-13	SKUAST, Kashmir, Srinagar.
T_{20}	IC 536593	NBPGR, New Delhi.
T_{21}	IC 538142	NBPGR, New Delhi.
T_{22}	IC342077	NBPGR, New Delhi.
T_{23}	IC417704	NBPGR, New Delhi.
T_{24}	IC398545	NBPGR, New Delhi.
T_{25}	KS-1	Kannika seeds, Thiruvananthapuram.
T_{26}	IC343153	NBPGR, New Delhi.
T_{27}	BG-1	SKUAST, Kashmir, Srinagar.
T_{28}	BG-2	SKUAST, Kashmir, Srinagar.
T_{29}	BG-3	SKUAST, Kashmir, Srinagar.
T_{30}	Naveen	Kyonic seeds, Bangalore.
T_{31}	BG-6	SKUAST, Kashmir, Srinagar.

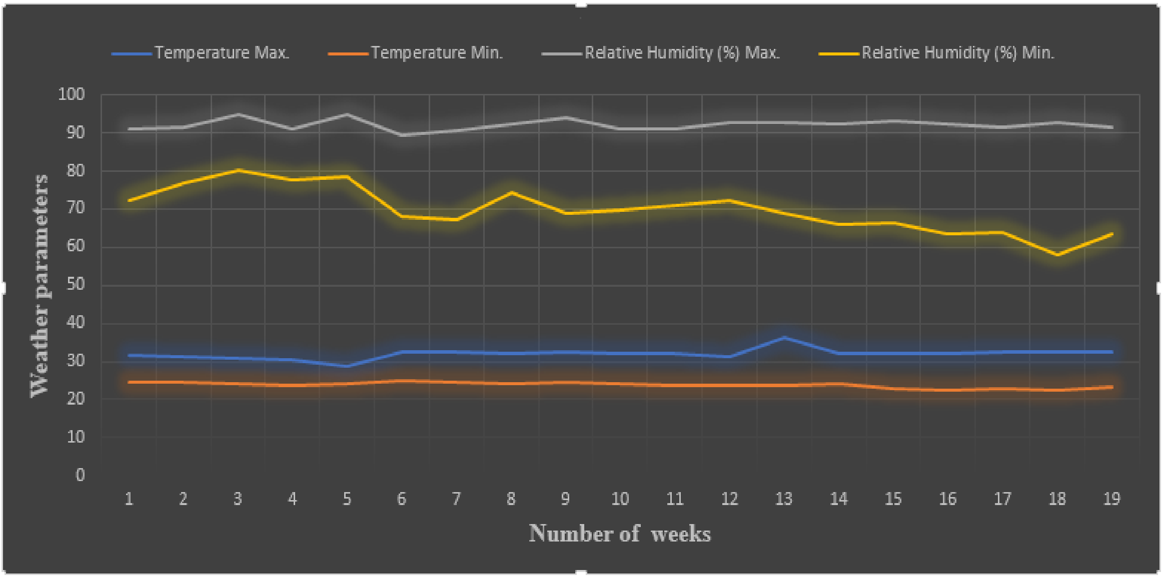


Fig. 1. Weathers parameters in open field during the cropping period in Oct. 2019 and Feb. 2020

3.3 METHODS

3.3.1 Design and Layout

Seeds of thirty-one genotypes of long type bottle gourd was collected from different states in India and sown under open field conditions. The crop was raised according to the package of practices recommendations (KAU, 2016) for bottle gourd**.**

The experiment was laid out as follows: -

Design	: RBD
Treatments	: 31
Replication	: 2
Spacing	: 3 m x 2 m
Plants pit^{-1}	: 3
Plants plot^{-1}	: 15
Plot size	: 45 m^2

3.3 OBSERVATIONS RECORDED

3.3.1 Vegetative Characters

Five plants were randomly selected from each plot and tagged for recording the biometric observations.

3.3.1.1 Plant Height (m)

The vine length was measured after final harvest from the above soil surface to the growing tip of the main branch with the help of meter tape and expressed in meter (m).

3.3.1.2 Number of Branches Vine^{-1}

The number of branches per plant was recorded from five randomly selected plant of each plot at the time of last harvest and average was presented as number of branches per vine^{-1}.

3.3.1.3 *Number of Leaves Vine^{-1} at 30 Days after Sowing (DAS)*

Plate. 1 General view of the experiment

The number of leaves of five randomly selected plants in every genotype was counted at 30 DAS and mean was worked out.

3.3.1.4 Inter Nodal Length (cm)

The inter-nodal length on the main stem was measured as distance between two nodes. Measured with the help of measuring tape in cm and average value was calculated.

3.3.2 B. Flowering Parameters

3.3.2.1 Days to First Male Flower

The days to first male flower anthesis of five randomly selected bottle gourd plants of every genotype was counted from sowing date to first appearance of male flower. The total value was averaged out in days.

3.3.2.2 Number of Node of Appearance of First Male Flower

The node number at which first male flower appeared was noted by counting its position from the first true leaf at the vine of five randomly selected plants of every genotype. The total value was averaged out in nodes**.**

3.3.2.3 Days to First Female Flower

The days to first female flower anthesis of five randomly selected plants of every genotype was counted from sowing date to first appearance of female flower. The total value was averaged out in days.

3.3.2.4 Number of Node of Appearance of First Female Flower

The node number at which first female flower appeared was noted by counting its position from the first true leaf at the vine of five randomly selected plants of every genotype. The total value was averaged out in nodes**.**

3.3.2.5 Number of Male Flowers

The total number of male flowers was counted starting from the commencement of flowering till its completion**.**

3.3.2.6 Number of Female Flowers

The total numbers of female flowers were counted starting from the commencement of flowering till its completion.

3.3.2.7 Sex Ratio (M/F)

Number of male and female flowers were counted starting from the commencement of flowering till its completion the sex ratio was calculated using the formula.

$$\text{Sex ratio} = \frac{\text{Number of male flowers per plant}}{\text{Number of female flowers per plant}}$$

3.3.3 Fruit yield parameters:

3.3.3.1 Node to First Fruit Initiation

The node number at which first fruit initiation appeared was noted by counting its position from the first true leaf at the vine of five randomly selected plants of every genotype. The total value was averaged out in nodes**.**

3.3.3.2 Fruit Set (%)

The percentage of fruit set was computed by using the following formula:

$$\text{Fruit set (\%)} = \frac{The\ total\ numbers\ of\ healthy\ fruits}{Total\ number\ of\ female\ flower}\ X\ 100$$

3.3.3.3 Days to First Harvest

Number of days taken from the date of sowing to the days to first harvest were counted and recorded.

3.3.3.4 Fruit Skin Colour

Every accession has a definite colour of fruit. The colour of fruit was found out with the help of Asian muslin paints colour chart which was used for jurisdiction of colour. The fruit colour was categorized in to different group green, light green, patchy green, bright green, whitish green etc.

3.3.3.5 Fruit shape

Every accession of bottle gourd has definite fruit shape. The fruit shape was categorized into elongate straight, elongate curved and cylindrical.

3.3.3.6 Fruit Length (cm)

Three harvested fruits of bottle gourd were measured with the help of meter scale in centimetre (cm) and then average fruit length was calculated for every accession.

3.3.3.7 Fruit Diameter (cm)

Fruit diameter of bottle gourd fruit was measured by cutting the fruit in the middle at vertical axis and the diameter of the fruit was measured across the fruit for three randomly selected fruits of tagged plants of each accession and the average was calculated and expressed in centimetre (cm).

3.3.3.8 Rind Thickness (mm)

Rind thickness of bottle gourd fruit was measured using digital Vernier callipers by separating the flesh from the skin of the bottle gourd fruit and expressed in millimetre (mm).

3.3.3.9 Flesh Thickness (cm)

Flesh thickness of bottle gourd fruit was measured with the help of thread and it is compared with meter scale by separating the flesh from the skin and expressed in centimetre (cm).

3.3.3.10 Fruit Weight (g)

The weight of three randomly selected tender bottle gourd fruits from labelled plants of each accession was measured with the help of weighing balance and average was calculated and expressed in grams (g).

3.3.3.11 Number of Fruits per Vine

The total number of harvested fruits of five labelled plants from each accession were counted and then average number of fruits per plant was calculated.

3.3.3.12 Yield Plant^{-1}(kg)

The weight of bottle gourd fruits plant^{-1} was measured by taking cumulative fruit yield of five labelled plants each accession was added and it was divided by five to calculate the fruit yield per plant and expressed in kilogram (kg).

3.3.3.13 Yield Plot^{-1} (kg)

The yield plot^{-1} was calculated by taking weight of each fruits in each plot of the accession and expressed in kilogram (kg).

3.3.3.13 Duration of Crop (days)

The crop duration of bottle gourd was calculated by counting the days from the date of sowing to final harvest of the crop and it is expressed in number of days.

3.3.4 Biochemical Parameters

3.3.4.1 T.S.S. (^{0}Brix)

The TSS in bottle gourd fruit pulp was determined directly from fruit juice obtained by squeezing the fruit pulp at room temperature with the help of hand refractometer scaling 0-32 per cent range and expressed in terms of ^{0} Brix.

3.3.4.2 Ascorbic Acid Content of the Pulp (mg/100g)

Ascorbic acid content of fruit was estimated by 2, 6-dichlorophenol indophenol dye method (Sadasivam and Manickam, 1992).

3.3.4.3 Dry Matter Content (%)

Dry matter content (%) determined by drying the flesh in an oven at 60-80°C until a constant weight and values were calculated using the formula (A.O.A.C., 1975).

$$\textit{Dry Matter Content (\%)} = \frac{\text{Dry weight}}{\text{Fresh weight}} \text{ X } 100$$

3.3.4.4 Crude Fibre Content (g/100g)

Crude fibre content of fruit was estimated by gravimetrically after chemical digestion and solubilisation method and values were calculated using the formula (Chulet *et al.*, 2010).

$$\text{Crude fibre (\%)} = \frac{\text{Weight of crude fiber}}{\text{Weight of sample taken}} \text{ X } 100$$

3.3.4.5 Potassium Content of the Pulp (mg/100 g)

The potassium content of the fruit pulp was estimated by nitric-per chloric (9:4) acid digestion and flame photometry method (Jackson, 1973).

3.3.4.6 Calcium Content of the Pulp (mg/100 g)

The calcium content of the fruit pulp was estimated by nitric-per chloric (9:4) acid digestion and atomic absorption spectrometry method (Piper, 1966).

3.4 STATISTICAL ANALYSIS

The data recorded were processed using the following statistical procedures.

3.4.1 Analysis of Variance

The observations recorded were subjected to ANOVA (Panse and Sukhatme, 1985) for comparison among various treatments and to estimate variance components.

ANOVA for each character

Sources of variation	**Degrees of freedom**	**Mean sum of squares**	**'F' ratio**
Replication	r-1	MSR	MSR/MSE
Treatment	t-1	MST	MST/MSE
Error	(r-1) (t-1)	MSE	
Total	rt-1		

Where, r = number of replications

t = number of treatments

MSR = mean sum of replication

MST = mean sum of treatments

MSE = mean sum of error

Critical difference (CD) = $t\alpha \sqrt{\frac{2MSE}{r}}$

Where, $t\alpha$ = Student's 't' table value at error degrees of freedom at α level of significance.

3.4.2 Estimation of Genetic Parameters

3.4.2.1 Genetic component of variance

The phenotypic and genotypic variances were calculated by utilizing the respective mean square values (Johnson *et al.*, 1955).

1) Genotypic variance (VG)

   VG = [MST−MSE r]

2) Environmental variance (VE)

   VE = MSE

3) Phenotypic variance (VP)

   VP = [VG + VE]

3.4.2.2 Coefficient of variation

The genotypic and phenotypic coefficients of variation are calculated as per Burton (1952).

1) Phenotypic coefficient of variation (PCV)

$$PCV = \frac{\sqrt{VP}}{\bar{X}} \text{ X } 100$$

2) Genotypic coefficient of variation (GCV)

$$GCV = \frac{\sqrt{VG}}{\bar{X}} \text{ X } 100$$

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

Categorization of the range of variation was followed as proposed by Sivasubramanian and Menon (1973).

Categories of Variation	Range of Variation (%)
Low	< 10 %
Moderate	10 to 20
High	> 20 %

3.4.2.3 Heritability

Heritability in the broad sense refers to the proportion of genotypic variance to the total observed variance in the total population. Heritability in broad sense was estimated for various characters and expressed in percentage (Allard, 1960).

$$\text{Heritability } (h^2) = \frac{VG}{VP} \times 100$$

As suggested by Johnson *et al.* (1955) heritability in broad sense estimates were categorized as

Categories of Heritability	Range of Heritability (%)
Low	< 30 %
Moderate	30 to 60
High	> 60 %

3.4.2.4 Genetic Advance

Genetic advance refers to the expected genetic gain or improvement in the next generation by selecting superior individuals under certain amount of selection pressure. It depends upon standardized selection differential, heritability and phenotypic standard deviation (Allard, 1960). The genetic advance was calculated in per cent by the formulae suggested by Johnson *et al.* (1955).

$$\text{Genetic advance (GA)} = k \times h^2 \sqrt{VP}$$

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

Where, k = standardized selection differential (2.06 at 5% selection intensity)
h^2 = heritability

The range of genetic advance as per cent (%) of mean was classified as suggested by Johnson *et al*. (1955).

Categories of GA	Range of GA (%)
Low	< 10 %
Moderate	10 to 20
High	> 20 %

3.4.2.5 Correlation Analysis

Phenotypic and genotypic correlation coefficients were calculated using the respective variance and covariance of the characters which showed significant variation in ANOVA.

Phenotypic correlation coefficient, ($r_{PX,Y}$) = $\frac{Cov_P\,(X,Y)}{\sqrt{V_P}\,(X),V_P(Y)}$

Genotypic correlation coefficient, ($r_{GX,Y}$) = $\frac{Cov_G\,(X,Y)}{\sqrt{V_G}\,(X),V_G(Y)}$

Where, Cov $_P$ (X, Y) = phenotypic variance (PV) between two traits X and Y

Cov $_G$ (X, Y) = genotypic covariance (GV) between two traits X and Y

V_P (X) and V_P (Y) = phenotypic variance (PV) for X and Y respectively

V_G (X) and V_G (Y) = genotypic variance (GV) for X and Y respectively

3.4.2.6 Path Coefficient Analysis

To study the cause and effect relationship of yield and its component characters, direct and indirect effects were analysed using path coefficient analysis as suggested by Dewey and Lu (1959).

3.4.2.7 Selection index

The selection index developed by Smith (1937) using discriminant function of Fisher (1936) was used to discriminate the genotypes based on all the characters.

The selection index is described by the function, I = b_1 x_1 + b_2 x_2 + ……. + b_k x_k and the merit of a plant is described by the function, H = a_1 G_1 + a_2 G_2 + ……+ b_k G_k where x_1, x_2…xk are the phenotypic values and G_1, G_2…. G_k are the genotypic values of the plants with respect to characters, x_1, x_2,……...x_k and H is the genetic worth of the plant. It is assumed that the economic weight assigned to each character is equal to unity i.e a_1, a_2...a_k =1

The regression coefficients (b) are determined such that the correlation between H and I is maximum. The procedure will reduce to an equation of the form,
b = p-1 Ga where, P is the phenotypic variance- covariance matrix and G is the genotypic variance - covariance matrix.

RESULTS

4. RESULTS

The present investigation was conducted at the Department of Vegetable Science, College of Agriculture, and Vellayani from 2019 to 2020 to evaluate the performance of bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] genotypes for growth, yield and quality characteristics. The experimental data were analysed statistically and the results are presented below.

4.1 ANALYSIS OF VARIANCE

Analysis of variance (ANOVA) for the experimental design indicated that the mean square (MS) due to genotypes/accessions were significant at $P \leq 0.05$ for all the traits studied. The mean sum of squares (MSS) of thirty-one characters is presented in Table 2.

4.1.1 Vegetative Characters

The mean performance of thirty-one long type bottle gourd accessions for vegetative characters like plant height (m) number of branches per vine, number of leaves vine^{-1}at 30 DAS, internodal length (cm) were noted and are presented in Table 3.

4.1.1.1 Plant Height (m)

A significant difference was recorded among the thirty-one accessions for the plant height. The mean plant height ranged from 2.69 m to 10.94 m with a treatment mean of 7.64 m. The accession Tvpm Local had the longest vine length of 10.94 m which was at par with KS-1 (9.80 m) and IC284895 (9.36 m). The lowest vine length of 2.69 m was recorded in accession BG-3.

4.1.1.2 Number of Branches per Vine

All thirty-one accessions significantly varied for the number of branches vine^{-1} and mean values ranged from 2.9 to 9.2 with an overall treatment mean of 4.85. The highest number of branches vine^{-1} was recorded in accession Tvpm Local (9.2)

Table 2 Analysis of variance for characters in bottle gourd accessions (Mean squares are given)

Character	Replication	Genotypes	Error
Plant height	1.69	5.85**	0.05
Number of branches vine-1	0.07	3.26**	0.09
Number of leaves $vine^{-1}$ at 30 DAS	4.23	21.15**	0.77
Inter nodal length	0.61	3.34**	0.12
Days to first male flower	0.64	14.08**	1.49
Number of node of appearance of first male flower	0.01	5.46**	0.42
Days to first female flower	0.08	18.14**	1.34
Number of node of appearance of first female flower	0.13	4.57**	0.59
Number of male flowers	0.17	661.59**	0.60
Number of female flowers	1.61	19.10**	0.64
Sex ratio	1.98	2.94**	0.35
Fruit set	61.16	78.91**	4.98
Node to first fruit initiation	0.15	4.13**	0.42
Days to first harvest	3.96	36.48**	0.87
Fruit length	2.71	190.79**	0.29
Fruit diameter	0.03	5.86**	0.04
Rind thickness	0.01	0.52**	0.02
Flesh thickness	0.08	6.15**	0.07
Fruit weight	619.61	225755.79**	3576.01
Number of fruits per vine	0.41	0.97**	0.05
Yield $plant^{-1}$	2.04	7.91**	0.20
Yield $plot^{-1}$	14.75	1927.24**	1.94
Duration of crop	39.31	97.09**	2.00
TSS	0.08	0.09**	0.01
Ascorbic acid content of the pulp	4.02	7.14**	1.55
Dry matter content	0.01	2.81**	0.06
Crude fiber content	0.15	8.08**	0.18
Potassium content of the pulp	1975.81	92306.45**	3059.14
Calcium content of the pulp	4032.26	45279.57**	4032.26

Data represent mean sum of squares; * significant at $P \leq 0.05$; **significant at $P \leq 0.01$

Table 3. Mean performance of bottle gourd genotypes for vegetative characters

Treatments		PH (m)	NBPV	NLPV 30 DAS	Inter nodal length (cm)
T1	**Arka Bahar**	8.69	3.9	10.6	20.72
T2	**Pusa Naveen**	8.07	4.3	11.7	21.17
T3	**Pant lauki-1**	7.59	4.6	12.8	18.65
T4	**Pant lauki-4**	8.64	6.0	13.6	21.21
T5	**Samrat**	8.55	6.4	13.7	20.67
T6	**BG-12**	8.47	4.7	13.6	20.24
T7	**KAR -1**	7.72	4.7	13.6	21.19
T8	**BG-8**	8.44	7.6	21.5	20.69
T9	**BG-11**	8.78	3.8	19.7	21.28
T10	**IC146312**	8.06	4.3	15.9	21.47
T11	**Tvpm Local**	10.94	9.2	17.3	19.15
T12	**IC 334300**	6.51	3.8	18.7	20.08
T13	**IC284891**	7.04	4.7	13.9	21.22
T14	**IC284895**	9.36	4.9	17.3	20.32
T15	**IC311135**	7.02	4.3	19.5	18.99
T16	**IC339196**	8.26	5.1	15.6	20.47
T17	**IC 331101**	7.43	4.4	14.4	19.93
T18	**IC 371745**	6.71	3.5	17.6	20.59
T19	**BG-13**	4.97	4.5	22.7	20.89
T20	**IC 536593**	8.43	5.5	14.5	17.00
T21	**IC 538142**	4.69	3.9	16.6	21.81
T22	**IC342077**	8.80	3.9	17.9	21.16
T23	**IC417704**	7.35	4.3	13.8	21.63
T24	**IC398545**	5.69	3.9	13.8	17.68
T25	**KS-1**	9.80	4.6	13.8	20.32
T26	**IC343153**	8.05	3.9	13.9	21.24
T27	**BG-1**	8.93	5.1	20.2	19.57
T28	**BG-2**	9.22	5.5	20.2	17.06
T29	**BG-3**	2.69	2.9	16.7	21.12
T30	**Naveen**	8.46	6.6	16.0	18.82
T31	**BG-6**	4.70	5.4	22.8	19.41
SEm(±)		**0.16**	**0.21**	**0.62**	**0.24**
CD (0.05)		**0.47**	**0.62**	**1.79**	**0.70**

PH: Plant height

NBPV: Number of branches per vine

NLPV 30 DAS: Number of leaves per vine at 30 days after sowing and BG-8 (7.6) and Naveen (6.6) was on par with it. BG-3 recorded the lowest number of branches vine^{-1} of 2.9.

4.1.1.3 Number of Leaves Vine^{-1} at 30 Days after Sowing (DAS)

There was a significant difference among the thirty-one accessions for the number of leaves vine^{-1} at 30 DAS ranged from 10.6 to 22.8 with a treatment mean of 16.38. The highest number of leaves vine^{-1} was recorded in accession BG-6 (22.8) which was at par with BG-2 (20.2). While, Arka Bahar recorded lowest number of leaves vine^{-1} (10.6).

4.1.1.4 Inter Nodal Length (cm)

Significant difference was recorded among the thirty-one accessions for internodal length. The mean internodal length ranged from 17 cm to 21.81 cm with an overall treatment mean of 20.17 cm. The accession IC 538142 produced longer internodal length of 21.81 cm and it was at par with BG-3 (21.12 cm). The accession IC 536593 had shorter internodal length of 17 cm.

4.1.2 Flowering Parameters

The mean values for flowering traits like days to first male flower, number of node of appearance of first male flower, days to first female flower, number of node of appearance of first female flower, number of male flowers, number of female flowers and sex ratio (M/F) are presented in Table 4.

4.1.2.1 Days to First Male Flower

All thirty-one accessions significantly varied for days to first male flower opening. The number of days ranged from 41.2 to 51.5 days with an overall treatment mean of 46.82 days. Accession BG-1 took the lowest number of days to appearance first male flower (41.2 days) and BG-3 (43.9 days) was on par. Accession IC 536593 took the highest number of days for appearance of the first male flower (51.5 days).

Table 4. Mean performance of bottle gourd genotypes for flowering characters

Treatments		DFMF	NNAFMF	DFFM	NNAFFF	NMF	NFF	SR (%)
T1	Arka Bahar	49	7.9	54.2	10.7	127.1	11.8	10.82
T2	Pusa Naveen	48	7.9	52.3	10.3	126.3	13.8	9.16
T3	Pant lauki-1	48.1	10.3	52.8	13	130.7	13.7	9.54
T4	Pant lauki-4	47.8	8.9	53.2	11.8	137.2	18.3	7.5
T5	Samrat	46.4	8.3	52.3	10.3	135.1	14.7	9.2
T6	BG-12	49.7	8.7	51.7	11.4	127.6	13.7	9.31
T7	KAR -1	49.7	12	53.5	14.1	137.6	13	10.63
T8	BG-8	45.7	8.2	49.3	10.5	130.8	14.7	8.92
T9	BG-11	44.5	9.5	47	13.5	126.4	13.4	9.49
T10	IC146312	49.2	9.7	53.8	12.7	126.7	13.2	9.61
T11	Tvpm Local	46.9	10.8	50.9	13.4	146.5	19.8	7.4
T12	IC 334300	44.4	8.3	50.4	10.6	120.6	10.4	11.75
T13	IC284891	50.2	8.5	56.6	13.2	131.5	13.6	9.68
T14	IC284895	45.5	9	50.4	12.2	132	12	11.04
T15	IC311135	45.9	9.2	51.2	12.2	123.7	11	11.26
T16	IC339196	47.4	9.1	52	12	130.7	13.8	9.69
T17	IC 331101	47.4	7.9	52.3	11.6	128.1	13.2	9.7
T18	IC 371745	46.5	9.2	51.8	11.6	108.6	9.3	11.71
T19	BG-13	47.8	10.2	47.1	12.9	110.5	12.1	9.19
T20	IC 536593	51.5	9.3	57.2	11.9	137.2	15.8	8.69
T21	IC 538142	46	9.6	51.3	12.4	100.4	11.7	8.58
T22	IC342077	47.2	9	53	11.4	131.3	22.1	5.96
T23	IC417704	44.8	8.2	50.8	10.8	133.7	15.5	8.64
T24	IC398545	51.3	14.5	56.4	16.7	116.7	12.9	9.07
T25	KS-1	49.7	8.9	54.7	12.8	134.2	14.5	9.28
T26	IC343153	47.3	9.6	53.4	13	134.6	14.5	9.3
T27	BG-1	41.2	7.7	47.3	10.2	136.8	15.1	9.06
T28	BG-2	41.3	6.5	44.3	9.9	141.8	17	8.34
T29	BG-3	43.9	7.3	50	11.6	46.9	5.3	8.85
T30	Naveen	46.7	10.6	54.3	11.9	133.5	14.8	9.03
T31	BG-6	41.7	6.1	46.6	9.3	100.2	10.6	9.46
SEm(±)		**0.82**	**0.46**	**0.82**	**0.55**	**0.55**	**0.57**	**0.42**
CD (0.05)		**2.36**	**1.33**	**2.36**	**1.57**	**1.59**	**1.64**	**1.21**

DFMF: Days to first male flower,
NNAFMF: Number of node of appearance of first male flower,
DFFM: Days to first female flower,
NNAFFF: Number of node of appearance of first female flower,
NMF: Number of male flowers,
NFF: Number of female flowers,
SR: Sex ratio (M/F).

4.1.2.2 Number of Node of Appearance of First Male Flower

There was significant difference among the thirty-one accessions for the number of node of appearance of first male flower. Then it ranged from 6.1 to 14.5 with an overall treatment mean of 9.14. The lowest node number was registered by BG-6 (6.1) which was statistically at par with BG-1 (7.7) and Pusa Naveen (7.9). The highest node number to first male flower was recorded in IC398545 (14.5).

4.1.2.3 Days to First Female Flower

The number of days taken to the first female flower opening was found significantly different among the thirty-one accessions. The mean number of days ranged from 44.3 to 57.2 with an overall treatment mean of 51.36 days. Accession BG-2 was the earliest for female flower production (44.3 days) which was at par with BG-6 (46.6 days). IC 536593 was late for female flower production (57.2 days).

4.1.2.4 Number of Node of Appearance of First Female Flower

There was significant difference among the thirty-one accessions for number of node of appearance of first female flower. The number of nodes ranged from 9.3 to 16.7 with an overall treatment mean of 11.99. The lowest node number was registered by BG-6 (9.3) which was statistically at par with IC417704 (10.8), and IC342077 (11.4). The highest node number was recorded in IC398545 (16.7).

4.1.2.5 Number of Male Flowers

All thirty-one accessions significantly varied for the number of male flowers. The number of male flowers was ranged from 46.9 to 146.5 with an overall treatment mean of 125.36. Accession Tvpm Local (146.5) and BG-2 (141.8), KAR-1 (137.6) were on par for number of male flowers. BG-3 had the lowest number of male flower (46.9 days).

4.1.2.6 Number of Female Flowers

There was significant difference among the thirty-one accessions for the number of female flowers. Female flowers production ranged from 5.3 to 22.1 with an overall treatment mean of 13.72. The highest number of female flowers was noted in accession IC342077 (22.1) and accession Tvpm Local (19.8) was on par. Accession BG-3 was noted for the lowest number of female flowers (5.3).

4.1.2.7 Sex Ratio (M/F)

Sex Ratio was found significantly different among the thirty-one accessions. Mean ranged from 5.96 to 11.75 with an overall treatment mean of 9.34 days. Accession IC342077 recorded the lowest sex ratio (5.96) followed by Tvpm Local (7.40), Pant Lauki-4 (7.50). IC 334300 had recorded the highest sex ratio (11.75).

4.1.3 Fruit Yield Parameters

Mean values for fruit yield traits like node to first fruit initiation, fruit set (%), days to first harvest, fruit skin colour, fruit shape, fruit length (cm), fruit diameter (cm), rind thickness (mm), flesh thickness (cm), fruit weight (g), number of fruits per vine, yield plant^{-1}(kg), yield plot^{-1} (kg) and duration of crop (days) are presented in Table 5.

4.1.3 .1 Node to First Fruit Initiation

The accessions differed significantly for the node to first fruit development with an overall treatment mean of 16.42. The lowermost node number was noted by BG-3 (13.7) which was at par with accession IC 284895 (15.0) and BG-13 (14.9). IC342077 recorded the highest node number to bear first fruit (19.4).

4.1.3 .2 Fruit Set (%)

Fruit Set (%) was found varied significantly among the thirty-one accessions. Mean ranged from 13.2 to 43.3 with an overall treatment mean of 26.55 per cent. Accession BG-3 was noted for highest fruit set per cent of 43.4 followed by

Table 5. Mean performance of bottle gourd genotypes for fruit yield character

Treatments		Node to first fruit initiation	Fruit set (%)	Days to first harvest	Fruit skin color
T1	Arka Bahar	18.9	35.9	67.2	Light green
T2	Pusa Naveen	16.7	25.4	71.9	Green
T3	Pant lauki-1	16.9	29.2	69.2	Light green
T4	Pant lauki-4	16.8	23.5	68.1	Light green
T5	Samrat	16.0	26.6	66.0	Light green
T6	BG-12	17.2	28.3	64.6	Light green
T7	KAR -1	18.1	27.1	70.5	Green
T8	BG-8	17.8	28.6	63.7	Light Green
T9	BG-11	15.1	24.8	63.0	Green
T10	IC146312	18.0	25.7	71.3	Green
T11	Typm Local	14.9	30.3	72.9	Light green
T12	IC 334300	17.5	35.1	68.3	Light green
T13	IC284891	16.2	24.4	74.1	Green
T14	IC284895	15.0	30.2	66.9	Green
T15	IC311135	14.8	28.2	65.2	Light green
T16	IC339196	16.7	28.2	68.2	Light green
T17	IC 331101	15.1	22.0	63.9	Green
T18	IC 371745	18.1	35.5	66.2	Green
T19	BG-13	14.9	34.8	59.6	Light green
T20	IC 536593	16.3	21.5	72.7	Green
T21	IC 538142	13.8	27.4	65.8	Green
T22	IC342077	19.4	13.2	65.0	Light green
T23	IC417704	17.2	22.0	71.3	Green
T24	IC398545	15.5	25.7	69.6	Green
T25	KS - 2	15.0	20.8	66.7	Patchy dark green
T26	IC343153	15.8	21.4	69.0	Light green
T27	BG-1	17.8	17.9	59.3	Light green
T28	BG-2	17.1	14.7	57.8	Light green
T29	BG-3	13.7	43.4	63.2	Patchy dark green
T30	Naveen	16.0	25.7	62.9	Light green
T31	BG-6	17.3	25.5	59.1	Green
SEm(±)		**0.46**	**1.58**	**0.66**	
CD (0.05)		**1.33**	**4.56**	**1.91**	

Arka Bahar (35.9%), IC 371745 (35.5%) and IC 334300 (35.1%). IC342077 recorded the lowest fruit set per cent of 13.2.

4.1.3 .3 Days to First Harvest

The number of days taken to first harvest significantly differed among the thirty-one accessions. Mean number of days ranged from 57.8 to 74.1 days with an overall treatment mean of 66.47 days. Accession BG-2 took the least number of days (57.8) for first harvest followed by Naveen (62.9 days), BG-3 (63.2 days) and BG-8 (63.7 days). IC284891 took the highest number of days (74.1) for first harvest.

4.1.3 .4 Fruit Skin Colour

Among thirty-one accessions, 16 accessions *viz.* Arka Bahar, Pant Lauki-1, Pant Lauki-4, Samrat, BG-12, Tvpm Local, IC 334300, IC311135, IC339196, BG-13, IC342077, IC343153, BG-1, BG-2, Naveen and BG-8 were noted for light green fruit skin colour, 12 accessions *viz.* Pusa Naveen, KAR-1, IC 146312, IC284891, IC284895, IC 331101, IC 371745, IC 536593, IC 538142, IC417704, IC398545, BG-8 and BG-11 were green fruit skin colour and remaining three accessions *viz*. KS-1, IC417704 and BG-3 noted for patchy dark green fruit skin colour.

4.1.3 .5 Fruit shape

Among the thirty-one accessions, twelve accessions *viz.,* IC284891, IC339196, IC 331101, IC 536593, IC342077, IC398545, KS-1, IC343153, BG-1, BG-3, BG-6 and BG-8 produced elongate curved fruit shape, eleven accessions *viz.,* Arka Bahar, IC146312, Tvpm Local, IC334300, IC284895, IC311135, IC 371745, BG-13, IC 538142, BG-2 and BG-11 produced elongate straight shaped fruits, while remaining eight accessions *viz.,* Pusa Naveen, Pant Lauki-1, Pant Lauki-4, Samrat, BG-12, KAR-1, IC417704, IC 371745 and Naveen produced cylindrical-shaped fruits.

4.1.3 .6 Fruit Length (cm)

Arka bahar

Pusa Naveen

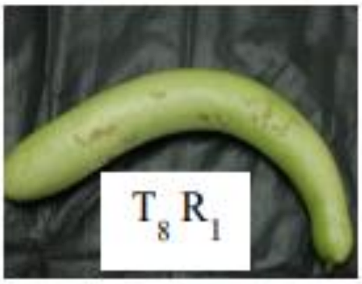
Pant lauki-1

Pant lauki-4

Samrat

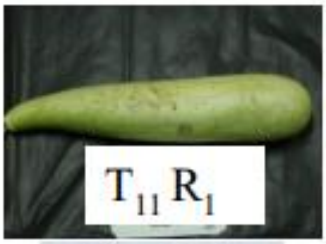
BG-12

KAR -1



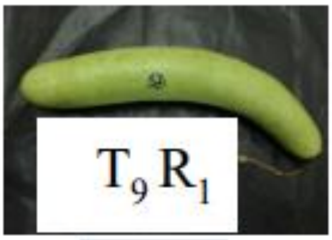
BG-8

2. Fruits of thirty-one bottle gourd genotypes



Tvpm Local

IC146312



BG-11

IC 334300

IC284891

IC284895

IC311135

IC339196

Plate 2. Continued

IC 331101

IC 371745

BG-13

IC 536593

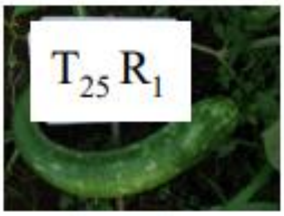
IC 538142

IC342077

IC417704

IC398545

Plate 2. Continued



KS-1

IC343153

BG-1

BG-2

BG-3

Naveen

BG-6

Plate 2. Continued

There was significant difference among the thirty-one accessions for fruit length. That ranged from 22.9 cm to 68.8 cm with an overall treatment mean of 48.04 cm. Accession IC 371745 recorded highest fruit length of 68.8 cm followed by IC 538142 (62.2 cm), BG-8 (60 cm) and BG-13 (58.9 cm). Accession BG-3 was recorded for lowest fruit length of 22.9 cm.

4.1.3 .7 Fruit Diameter (cm)

The accessions differed significantly for fruit diameter with an overall treatment mean of 7.35 cm. IC417704 had recorded the highest fruit diameter of 15.97 cm which was at par with accessions IC146312 (13.38 cm), IC342077 (17.75 cm) and IC 536593 (11.55 cm). BG-1 and Naveen recorded for least fruit diameter of 7.35 cm.

4.1.3 .8 Rind Thickness (mm)

Rind thickness was found differ significantly among the thirty-one accessions. Mean ranged from 1.69 mm to 3.79 mm with an overall treatment mean of 2.93 mm. Accession IC 331101 recorded least rind thickness of 1.69 mm and IC284895 (2.30 mm) was on par with it. IC 538142 recorded the highest rind thickness of 3.79 mm.

4.1.3 .9 Flesh Thickness (cm)

All thirty-one accessions significantly varied for flesh thickness. Mean was ranged from 12.56 cm to 4.19 cm with an overall treatment mean of 7.25 cm. Accession IC417704 had highest rind thickness of 12.56 cm and IC146312 (10.95 cm), IC342077 (9.97 cm) and IC 536593 (8.65 cm) were on par with it. Naveen recorded for lowest flesh thickness of 4.19 cm.

4.1.3 .10 Fruit Weight (g)

Table 5. Mean performance of bottle gourd genotypes for fruit yield character

(Continued)

Treatments		Fruit shape	Fruit length (cm)	Fruit diameter (cm)	Rind thickness (mm)
T1	Arka Bahar	Elongate straight	47.8	9.83	3.46
T2	Pusa Naveen	Cylindrical	34.5	9.96	2.77
T3	Pant lauki-1	Cylindrical	50.3	11.35	3.19
T4	Pant lauki-4	Cylindrical	55	10.7	2.33
T5	Samrat	Cylindrical	45.4	10.86	3.09
T6	BG-12	Cylindrical	44.3	8.57	3.2
T7	KAR -1	Cylindrical	42.8	11.04	2.39
T8	BG-8	Elongate curved	60	9.73	3.59
T9	BG-11	Elongate straight	48.8	10.26	2.49
T10	IC146312	Elongate straight	47.1	13.38	2.43
T11	Tvpm Local	Elongate straight	52.1	8.58	2.83
T12	IC 334300	Elongate straight	50.7	10.61	3.57
T13	IC284891	Elongate curved	41	10.18	3.32
T14	IC284895	Elongate straight	40	10.02	2.3
T15	IC311135	Elongate straight	51.4	10.14	2.61
T16	IC339196	Elongate curved	47.4	10.35	2.9
T17	IC 331101	Elongate curved	51.9	9.93	1.7
T18	IC 371745	Elongate straight	68.8	9.55	2.52
T19	BG-13	Elongate straight	58.9	7.92	3.54
T20	IC 536593	Elongate curved	42.9	11.55	3.77
T21	IC 538142	Elongate straight	62.2	10.69	3.79
T22	IC342077	Elongate curved	57.8	12.75	2.78
T23	IC417704	Cylindrical	33	15.97	3.42
T24	IC398545	Elongate curved	52.3	9.83	2.71
T25	KS - 1	Elongate curved	40.8	9.35	2.85
T26	IC343153	Elongate curved	50.9	10.82	3.51
T27	BG-1	Elongate curved	56.6	7.35	2.81
T28	BG-2	Elongate straight	39.9	9.42	2.57
T29	BG-3	Elongate curved	22.9	8.87	3
T30	Naveen	Cylindrical	52	7.35	3.16
T31	BG-6	Elongate curved	32.1	9.84	2.37
SEm(±)			**0.38**	**0.13**	**0.1**
CD (0.05)			**1.1**	**0.39**	**0.3**

Table 5. Mean performance of bottle gourd genotypes for fruit yield character (Continued)

Treatments		Flesh thickness (cm)	Fruit weight (g)	Number of fruits per vine
T1	**Arka Bahar**	6.38	1590	4.2
T2	**Pusa Naveen**	7.19	2165	3.5
T3	**Pant lauki-1**	8.16	2235	4
T4	**Pant lauki-4**	8.37	2220	4.3
T5	**Samrat**	7.77	1840	3.9
T6	**BG-12**	5.37	2080	3.9
T7	**KAR -1**	8.65	1555	3.5
T8	**BG-8**	6.14	2085	4.2
T9	**BG-11**	7.77	1775	3.3
T10	**IC146312**	10.95	2105	3.4
T11	**Tvpm Local**	5.75	2300	6
T12	**IC 334300**	7.04	1855	3.6
T13	**IC284891**	6.86	1746	3.3
T14	**IC284895**	7.72	2000	3.6
T15	**IC311135**	7.53	1765	3.1
T16	**IC339196**	7.44	1954.4	3.9
T17	**IC 331101**	8.23	1875	2.9
T18	**IC 371745**	7.03	2080	3.3
T19	**BG-13**	4.38	1885	4.2
T20	**IC 536593**	7.78	2410	3.4
T21	**IC 538142**	6.9	1860	3.2
T22	**IC342077**	9.97	1945	2.9
T23	**IC417704**	12.56	1965	3.4
T24	**IC398545**	7.12	1940	3.3
T25	**KS- 1**	6.5	1810	3
T26	**IC343153**	7.31	2095	3.1
T27	**BG-1**	4.54	1980	2.7
T28	**BG-2**	6.85	1730	2.5
T29	**BG-3**	5.87	504	2.3
T30	**Naveen**	4.19	2055	3.8
T31	**BG-6**	7.47	1790	2.7
SEm(±)		**0.18**	**42.28**	**0.16**
CD (0.05)		**0.53**	**122.13**	**0.46**

Fruit weight was found significantly different among the thirty-one accessions. Mean ranged from 504.0 to 2410.0 g with an overall treatment mean of 1894.0 g. Accession IC 536593 was recorded for the highest fruit weight (2410.0 g) which was at par with Pant Lauki-1 (2235.0 g), Pant Lauki-4 (2220.0 g) and Pusa Naveen (2165.0 g). BG-3 recorded the lowest fruit weight of 504.0 g.

4.1.3 .11 Number of Fruits per Vine

The accessions differed significantly for the number of fruits per vine. Mean ranged from 2.3 to 6 with an overall treatment mean of 3.5. Tvpm Local had recorded for highest number of fruits of 6 fruits per vine followed by Pant Lauki-4 (4.3) and Arka Bahar (4.2). Accessions BG-3 recorded for a lowest number of fruits per vine of 2.3.

4.1.3 .12 Yield Plant^{-1} (kg)

All thirty-one accessions significantly varied for yield plant^{-1}. Mean was ranged from 1.1 to 13.0 kg with an overall treatment mean of 6.69 kg. Accession Tvpm Local recorded highest yield per plant of 13.0 kg followed by Naveen (9.4 kg), Pant Lauki-4 (9.3 kg) and Pant Lauki-1 (9 kg). BG-3 had recorded lowest yield per plant of 1.1 kg.

4.1.3 .13 Yield Plot^{-1} (kg)

There was significant difference among the thirty-one accessions for yield per plot. Mean ranged from 17.3 kg to 197.9 kg with an overall treatment mean of 104.6 kg. Accession Tvpm Local recorded maximum yield per plot (197.9 kg) which was at par with Naveen (148.4 kg), Pant Lauki-4 (146.9 kg) and Pant Lauki-1 (141.8 kg). Accession BG-3 was recorded the lowest fruit weight per plot of 17.3 kg.

4.1.3 .14 Duration of Crop (days)

The 31 accessions differed significantly for duration of the crop. Mean ranged from 99.9 to 137.2 days with overall treatment mean of 123.57 days. The

Table 5. Mean performance of bottle gourd genotypes for fruit yield character (Continued)

Treatments		Yield plant^{-1} (kg)	Yield plot^{-1} (kg)	Duration of crop (days)
T1	Arka Bahar	6.9	106.7	124.2
T2	Pusa Naveen	7.3	107.7	129.3
T3	Pant lauki-1	9.0	141.8	126.4
T4	Pant lauki-4	9.3	146.9	125.6
T5	Samrat	7.3	116.9	121.5
T6	BG-12	7.4	116.5	117.6
T7	KAR -1	5.6	90.5	128.5
T8	BG-8	8.2	129.9	119.2
T9	BG-11	6.0	97.0	130.0
T10	IC146312	7.7	119.2	129.3
T11	Tvpm Local	13.0	197.9	129.4
T12	IC 334300	6.6	96.8	125.8
T13	IC284891	5.8	96.4	133.6
T14	IC284895	6.9	115.1	124.4
T15	IC311135	5.3	81.8	119.7
T16	IC339196	7.5	117.4	125.6
T17	IC 331101	5.4	83.6	121.9
T18	IC 371745	6.8	95.7	124.2
T19	BG-13	8.0	135.4	120.1
T20	IC 536593	8.0	122.5	131.7
T21	IC 538142	5.7	88.2	123.9
T22	IC342077	5.3	81.4	122.9
T23	IC417704	6.1	93.0	137.2
T24	IC398545	6.5	98.3	127.6
T25	KS - 1	5.7	87.2	124.7
T26	IC343153	6.5	99.6	128.0
T27	BG-1	5.5	83.8	116.8
T28	BG-2	4.3	74.4	115.8
T29	BG-3	1.1	17.3	100.0
T30	Naveen	9.4	148.4	114.9
T31	BG-6	5.0	76.3	117.1
SEm(±)		**0.31**	**0.99**	**1.00**
CD (0.05)		**0.91**	**2.85**	**2.89**

accession IC417704 recorded for the maximum duration of 137.2 days and IC284891 (133.6 days) and IC 536593 (131.7 days) were on par with it. BG-3 recorded for minimum crop duration of 99.9 days.

4.1.4 Biochemical Parameters

The mean values for biochemical traits like T.S.S. (^{0}Brix), ascorbic acid content of the pulp (mg/100g), dry matter content (%), crude fibre content (g/100 g), potassium(K) content of the pulp (mg/100 g), calcium (Ca) content of the pulp (mg/100 g) and are presented in Table 6.

4.1.4.1 T.S.S. (^{0}Brix)

Total soluble solids (TSS) content of fruit pulp varied significantly among 31 accessions and it ranged from 1.5 to 2.5 °B with an overall treatment mean of 1.96° B. The highest TSS content was noted in the accession BG-3 (2.5 °B). The lowest TSS content was noted in Naveen (1.5°B).

4.1.4.2 Ascorbic Acid Content of the Pulp (mg/100 g)

There was significant difference among the thirty-one accessions for ascorbic acid content of the pulp. Mean ranged from 5.26 to 12.0 mg/100 g with an overall treatment mean of 8.16 mg/100 g. Accession IC398545 recorded highest ascorbic acid content of 12.0 mg/100 g and IC 371745 (10.5 mg/100 g) were on par with it. Accession BG-13 recorded lowest ascorbic acid content of 5.3 mg/100 g.

4.1.4.4 Dry Matter Content (%)

All thirty-one accessions significantly varied for dry matter content of fruit. Mean ranged from 2.18 to 6.71 per cent, with an overall treatment mean of 4.26 per cent. Accession BG-3 recorded for highest dry matter content of 6.71 per cent followed by KAR-1 (5.93 %), IC 371745 (5.91 %) and Samrat (5.76 %). IC 334300 recorded for lowest dry matter content of 2.18 per cent.

Table 6. Mean performance of bottle gourd genotypes for biochemical characters

Treatments		TSS (^{0}Brix)	AACP ($mg100^{-1}g$)	DMC (%)	CFC ($g100^{-1}g$)	PCP ($mg100^{-1}g$)	CCP ($mg100^{-1}g$)
T1	Arka Bahar	2.15	9.2	5.22	20.2	2575	1350
T2	Pusa Naveen	1.95	10.5	5.12	20.8	3025	1500
T3	Pant lauki-1	2.1	7.9	5.58	21.8	2625	1350
T4	Pant lauki-4	1.75	7.9	5.06	22.7	2750	1550
T5	Samrat	2.15	5.3	5.76	19.8	2425	1350
T6	BG-12	2	7.9	3.29	18.4	2325	1150
T7	KAR -1	1.95	6.6	5.93	20.1	2350	1100
T8	BG-8	1.85	9.2	4.31	20.1	2275	1350
T9	BG-11	1.95	6.6	4.19	23.3	2400	1150
T10	IC146312	1.8	6.6	4.6	22.8	2525	1150
T11	Typm Local	2.25	7.9	2.7	22.4	2575	1400
T12	IC 334300	1.85	9.2	2.18	19.8	2600	1450
T13	IC284891	2.15	7.9	5.07	21.2	2600	1300
T14	IC284895	1.95	9.2	3.21	22.3	2375	1550
T15	IC311135	2.2	7.9	4.3	22.9	2675	1400
T16	IC339196	2	11.8	4.43	21.2	2540	1340
T17	IC 331101	1.85	9.4	3.56	21.8	2400	1350
T18	IC 371745	1.85	10.5	5.91	23.8	2375	1100
T19	BG-13	1.8	5.3	3.41	24.8	2400	1250
T20	IC 536593	2.05	10.5	4.54	25.9	2550	1550
T21	IC 538142	1.75	6.6	4.27	22.9	2325	1350
T22	IC342077	2	7.9	3.51	21.9	2300	1450
T23	IC417704	2.25	9.2	2.53	27.2	3125	1600
T24	IC398545	1.95	12	2.79	23.8	2525	1350
T25	KS - 1	2.15	7.9	4.2	24.2	2350	1150
T26	IC343153	1.9	9.2	5.02	22.2	2325	1400
T27	BG-1	1.6	5.3	3.82	21.2	2375	1450
T28	BG-2	1.85	5.3	2.95	21.8	2275	1200
T29	BG-3	2.5	5.3	6.71	18.2	2125	1050
T30	Naveen	1.5	9.2	4.84	20.7	2700	1350
T31	BG-6	1.7	7.9	5.22	20.9	2300	1300
SEm(±)		**0.07**	**0.88**	**0.17**	**0.3**	**39.11**	**44.9**
CD (0.05)		**0.2**	**2.54**	**0.48**	**0.88**	**112.96**	**129.68**

TSS (^{0}Brix): Total soluble solids

AACP (mg100-1g): Ascorbic acid content of the pulp ($mg100^{-1}g$)

DMC (%): Dry matter content (%)

CFC (g100-1g): Crude fiber content ($g100^{-1}g$)

PCP (mg100-1g): Potassium (K) content of the pulp ($mg100^{-1}g$)

CCP (mg100-1g): Calcium (Ca) content of the pulp ($mg100^{-1}g$)

4.1.4.5 Crude Fibre Content (g/100g)

Crude fibre content (g/100 g) content of fruit pulp varied significantly among 31 accessions and it ranged from 18.2 to 27.2 g/100 g with an overall treatment mean of 22.01 g/100 g. The highest crude fibre content was recorded in the accession IC417704 (27.2 g). The lowest crude fibre content was noted in BG-3 (18.2 g/100 g).

4.1.4.6 Potassium Content of the Pulp (mg/100 g)

The accessions differed significantly for the trait potassium content of the pulp (mg/100 g). Mean ranged from 2125 to 3125 mg/100 g with an overall treatment mean of 2484.68 mg/100 g. IC417704 recorded for a highest of 3125 mg/100 g followed by Pusa Naveen (3025 mg/100g), Pant Lauki-4 (2750 mg/100g) and Naveen (2700 mg/100g). Accessions BG-3 recorded for lowest potassium content of 2125 mg/100 g.

4.1.4.7 Calcium Content of the Pulp (mg/100 g)

Calcium content of the pulp varied significantly among 31 accessions and it ranged from 1600 to 1050 mg/100 g with an overall treatment mean of 1327 mg/100 g. The highest calcium content was recorded in the accession IC417704 with 1600 mg/100 g. The lowest was noted in BG-3 (1050 mg/100 g).

4.2 PEST AND DISEASE INCIDENCE

The crop was supervised for the incidence of insect-pests and diseases throughout the cropping season. At the earlier stage of crop growth, incidence of red pumpkin beetle (*Aulacophora faveicollis*) was noted and chemical quinalphos (25 EC @ 0.1ml L^{-1}) was sprayed to control the pest. A sporadic incidence of cercospora leaf spot was also noticed during final fruit harvest stage.

4.3 GENETIC VARIABILITY PARAMETERS

The population means, range, GCV, PCV, heritability and genetic advance of thirty-one genotypes are presented in Table 7.

4.3.1 Vegetative Characters

Plate 3. Incidence of disease: Cercosepora leaf spot

Plate 4. Incidence of pest: Red pumpkin beetle infestation symptom on leaves

A high estimate of PCV (22.50) and GCV (22.30) were recorded for plant height. This trait also exhibited high heritability (98.21 per cent) and high genetic advance (45.52).

High PCV and GCV values (26.67 and 25.92 respectively) coupled with high heritability (94.49 per cent) and high genetic advance (51.91) was evident for number of branches vine^{-1}.

Number of leaves vine^{-1} at 30 DAS exhibited high PCV (20.21) and moderate GCV (19.49) values with high heritability (92.97 per cent) as well as high genetic advance estimates (38.70).

Low PCV and GCV values with narrow difference between them (6.52 and 6.29 respectively) coupled with high heritability (93.27 per cent) and moderate genetic advance (12.52) were noted for the trait, inter nodal length.

4.3.2. ***Flowering Characters***

Days to first male flower exhibited low PCV (5.96) and GCV (6.36) values with high heritability (80.90 per cent) and low genetic advance estimates (9.93).

Moderate estimate of PCV (18.75) and GCV (17.36) were recorded for number of node of appearance of first male flower. This trait also exhibited high heritability (85.68 per cent) and high genetic advance (33.10).

Low PCV and GCV values with narrow difference between them (6.04 and 5.61 respectively) coupled with high heritability (86.25 per cent) and moderate genetic advance (10.73) were noted for the trait, days to first female flower.

Number of node of appearance of first female flower exhibited moderate PCV (13.40) and GCV (11.76) values with high heritability (76.97 per cent) and high genetic advance estimates (21.97).

Moderate estimate of PCV (14.51) and GCV (14.50) were recorded for number male flower. This trait also exhibited high heritability (99.82 per cent) and high genetic advance (29.85).

Table 7. Estimates of genetic parameters for various characters in bottle gourd accessions

Character	Range	Mean	PCV	GCV	Heritability (%)	Genetic Advance	GA as percent of mean
Plant height	8.25	7.64	22.5	22.3	98.21	3.48	45.52
Number of branches vine-^{1}	6.3	4.85	26.67	25.92	94.49	2.52	51.91
Number of leaves vine^{-1} at 30 DAS	12.1	16.38	20.21	19.49	92.97	6.34	38.7
Inter nodal length	4.82	20.17	6.52	6.29	93.27	2.53	12.52
Days to first male flower	10.3	46.82	5.96	5.36	80.9	4.65	9.93
Number of node of appearance of first male flower	8	9.14	18.75	17.36	85.68	3.03	33.1
Days to first female flower	12.9	51.67	6.04	5.61	86.25	5.55	10.73
Number of node of appearance of first female flower	6.8	11.99	13.4	11.76	76.97	2.55	21.97
Number of male flowers	99.6	125.36	14.51	14.5	99.82	37.42	29.85
Number of female flowers	16.8	13.72	22.89	22.14	93.49	6.05	44.09
Sex ratio	5.79	9.34	13.73	12.17	78.59	2.08	22.23
Fruit set	30.2	26.55	24.39	22.9	88.13	11.76	44.28
Node to first fruit initiation	5.7	16.42	8.29	9.19	81.48	2.53	15.42
Days to first harvest	16.3	66.47	6.5	6.35	95.32	8.49	12.77
Fruit length	45.96	48.04	20.35	20.32	99.7	20.07	41.79
Fruit diameter	8.62	7.35	16.87	16.77	98.79	3.49	34.34
Rind thickness	2.09	2.93	17.78	17.08	92.27	0.99	33.79
Flesh thickness	8.37	7.25	24.33	24.06	97.82	3.55	49.03
Fruit weight	1906	1894.2	17.88	17.6	96.88	675.81	35.68
Number of fruits per vine	3.7	3.5	20.43	19.38	89.96	1.32	37.86
Yield plant^{-1}	11.89	6.65	30.1	29.35	95.12	3.95	58.98
Yield plot^{-1}	180.63	104.6	29.69	29.66	99.8	63.85	61.04
Duration of crop	37.25	123.5	5.58	5.7	95.97	13.92	11.26
TSS	1	1.96	11.27	10.04	79.38	0.36	18.42
Ascorbic acid content of the pulp	6.76	8.16	25.55	20.49	64.32	2.76	33.85
Dry matter content	4.53	4.26	28.1	27.55	96.09	2.37	55.63
Crude fiber content	9	22.01	9.24	9.03	95.55	4	18.18
Potassium content of the pulp	1000	2484	8.79	8.5	93.58	420.97	16.94
Calcium content of the pulp	550	1327	11.83	10.82	83.65	270.57	20.38

High PCV and GCV values with narrow difference (22.89 and 22.14 respectively) coupled high heritability (93.49 per cent) and high genetic advance (44.09) were noted for number of female flowers.

Sex ratio (%) exhibited moderate PCV (13.73) and GCV (12.17) values with high heritability (78.59 per cent) as well as high genetic advance estimates (22.23).

4.3.3. Fruit Yield Parameters

High estimate of PCV (24.39) and GCV (22.90) were recorded for the trait fruit set (%). This trait also exhibited high heritability (88.13 per cent) and high genetic advance (44.28).

Low PCV and GCV values with narrow difference between them (8.29 and 9.19 respectively) coupled with high heritability (81.48 cent) and moderate genetic advance (15.42) were noted node to first fruit initiation.

Days to first harvest exhibited low PCV (6.50) and GCV (6.35) values with high heritability (95.32 per cent) and moderate genetic advance estimates (12.77).

High PCV and GCV values with narrow difference between them (20.35 and 20.32 respectively) coupled with high heritability (99.70 per cent) and high genetic advance (41.79) were noted fruit length.

Moderate estimate of PCV (16.87) and GCV (16.77) were noted for fruit diameter. This trait also exhibited high heritability (98.79 per cent) and high genetic advance (34.34).

Rind thickness exhibited moderate PCV (17.78) and GCV (17.08) values with high heritability (92.27 per cent) as well as high genetic advance estimates (33.79).

High estimate of PCV (24.33) and GCV (24.06) were recorded for the trait flesh thickness. This trait also exhibited high heritability (97.87 per cent) and high genetic advance (49.03).

Moderate PCV and GCV values (17.88 and 17.60 respectively) with high heritability (96.88 per cent) and high genetic advance (35.68) were noted fruit weight.

Number of fruits per vine exhibited high PCV (20.43) and moderate GCV (19.38) values with high heritability (89.96 per cent) as well as high genetic advance estimates (37.86).

High PCV and GCV values (30.10 and 29.35 respectively) with high heritability (95.12 per cent) and high genetic advance (58.98) were noted yield per plant.

High estimate of PCV (29.69) and GCV (29.66) were noted for yield per plot. This trait also exhibited high heritability (99.8 per cent) as well as genetic advance (63.85).

Duration of crop exhibited low PCV (5.58) and GCV (5.70) values with high heritability (95.97 per cent) and moderate genetic advance estimates (11.26).

4.3.4. Biochemical Parameters

A moderate PCV (11.27) and GCV (10.04) was recorded along with high heritability (79.38 per cent) and moderate genetic advance (18.42) for TSS.

Ascorbic acid content of the pulp showed high value for PCV (25.55) and GCV (20.49) along with high heritability (64.32 per cent) and genetic advance (33.85) estimates.

High PCV and GCV values (28.10 and 27.55 respectively) with high heritability (96.55 per cent) and high genetic advance (55.63) were noted for dry matter content.

A low PCV (9.24) and GCV (9.03) was recorded along with high heritability (95.55 per cent) and moderate genetic advance (18.18) for crude fibre content.

Low PCV and GCV values (8.79 and 8.50 respectively) with high heritability (93.58 per cent) and moderate genetic advance (16.94) were noted for potassium content of the pulp.

Calcium content of the pulp showed moderate value for PCV (11.83) and GCV (10.82) along with high heritability (83.65 per cent) as well as genetic advance (20.38) estimates.

4.4 CORRELATION ANALYSIS

Genotypic and phenotypic correlation coefficients between yield and various yield components and interrelationship between the characters were computed and are presented in Table 8 and Table 9. In general, genotypic correlation coefficients were higher than the phenotypic correlation coefficients.

4.4.1 Genotypic Correlation

The fruit yield per plant had significant (at p = 0.01) positive association at genotypic level with number of fruits per vine (rP = 0.900), fruit weight (rP = 0.770), number of branches vine^{-1} (rP = 0.693), number of male flowers (rP = 0.579), plant height (rP = 0.554), number of female flowers (rP = 0.501), duration of crop (rP = 0.449), fruit length (rP = 0.407), days to first harvest (rP = 0.390), number of node of appearance of first male flower (rP = 0.389) and days to first male flower (rP = 0.386). Number of leaves per vine 30 DAS, internodal length, sex ratio, fruit diameter and flesh thickness had a negative relationship with yield.

The genotypic correlation co-efficient was found to be highly significant (at p = 0.01) and positive for plant height with number of male flowers (rP = 0.803), number of female flowers (rP = 0.698), fruit weight (rP = 0.586), yield plant^{-1} (rP = 0.554), number of branches vine-^{1} (rP = 0.547), number of fruits per vine (rP =0.411), fruit set per cent (rP = 0.359) and duration of crop (rP = 0.295) but it was negatively and significantly (at p = 0.01) associated with number of leaves vine^{-1}at 30 DAS (rP = -0.540) and node to first fruit initiation (rP = -0.457).

Genotypic correlation co-efficient for number of branches per vine recorded significant (at p = 0.01) and positive association with yield plant^{-1} (rP = 0.693), number of fruits per vine (rP = 0.688), number of female flowers (rP = 0.549), number of male flowers (rP = 0.508), fruit weight (rP = 0.421) and it was negatively and significantly associated with sex ratio (rP = -0.375) at p = 0.01 while, inter nodal

Table 8. Genotypic correlation coefficients between yield and yield component

GCM	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	X_{21}	X_{22}
X_1	1																					
X_2	0.547**	1																				
X_3	-0.540**	0.177	1																			
X_4	-0.2388	-0.316*	-0.129	1																		
X_5	0.2323	-0.05	-0.711**	0.019	1																	
X_6	-0.0097	0.051	-0.196	-0.148	0.611**	1																
X_7	0.299*	-0.095	-0.787**	0.017	0.945**	0.518**	1															
X_8	-0.1539	-0.111	-0.213	-0.061	0.657**	0.939**	0.513**	1														
X_9	0.803**	0.508**	-0.203	-0.221	0.236	0.186	0.199	0.055	1													
X_{10}	0.698**	0.549**	-0.088	-0.151	0.142	0.117	0.127	-0.013	0.765**	1												
X_{11}	-0.1982	-0.375**	-0.024	0.028	0.005	-0.005	0.01	0.035	-0.133	-0.715**	1											
X_{12}	-0.457**	-0.152	0.022	0.226	0.028	0.091	-0.037	0.103	-0.630**	-0.737**	0.506**	1										
X_{13}	0.359**	-0.013	-0.069	0.053	0.02	-0.234	0.07	-0.443**	0.367**	0.306*	0.044	-0.254*	1									
X_{14}	0.302*	0.027	-0.689**	0.155	0.722**	0.415**	0.758**	0.445**	0.286*	0.17	0.054	0.053	0.057	1								
X_{15}	0.1108	0.136	0.243	0.027	0.107	0.401**	0.036	0.242	0.260*	0.245	0.001	-0.045	0.159	-0.119	1							
X_{16}	0.0278	-0.260*	-0.323*	0.300*	0.174	-0.033	0.264*	-0.019	0.148	0.213	-0.129	-0.280*	0.317*	0.507**	-0.194	1						
X_{17}	-0.0791	0.021	-0.082	0.043	0.16	-0.005	0.18	-0.118	-0.068	-0.037	-0.067	0.206	-0.013	0.183	0.086	0.07	1					
X_{18}	0.0499	-0.260*	-0.292*	0.281*	0.125	-0.031	0.207	0.015	0.164	0.219	-0.107	-0.333**	0.314*	0.443**	-0.214	0.958**	-0.218	1				
X_{19}	0.586**	0.421**	-0.131	-0.231	0.303*	0.173	0.219	-0.011	0.688**	0.586**	-0.167	-0.435**	0.277*	0.324*	0.429**	0.175	0.087	0.146	1			
X_{20}	0.411**	0.688**	-0.1341	0.0316	0.321*	0.405**	0.167	0.2285	0.421**	0.361**	-0.0971	0.281*	0.0122	0.387**	0.329**	-0.1235	0.2006	-0.1783	0.451**	1		
X_{21}	0.295*	0.0205	-0.412**	0.143	0.508**	0.325**	0.435**	0.356**	0.589**	0.396**	0.0214	-0.314*	0.2104	0.749**	0.1067	0.601**	0.1061	0.557**	0.606**	0.341**	1	
X_{22}	0.554**	0.693**	-0.1562	-0.146	0.386**	0.389**	0.2452	0.1787	0.579**	0.501**	-0.1568	0.0172	0.0841	0.390**	0.407**	-0.0682	0.1632	-0.1135	0.770**	0.900**	0.449**	1

GCM: Genotypic correlation matrix

length (rP = -0.316), fruit diameter (rP = -0.260) were significant at p = 0.05. Number of leaves vine^{-1}at 30 DAS showed positive association with fruit length (rP = 0.243) and node to first fruit initiation (rP = 0.022). But it showed highly significant (at p = 0.01) and negative association with days to first female flower (rP = -0.787), days to first male flower (rP = -0.711), days to first harvest (rP = -0.689) and duration of crop (rP = -0.412).

Inter nodal length exhibited highly significant (at p = 0.05) and positive association with fruit diameter (rP=0.300) and flesh thickness (rP = 0.281). But negatively correlated with yield plant^{-1} (rP = -0.146).

Days to first male flower had highly significant (at p = 0.01) and negative association with days to first female flower (rP = 0.945), days to first harvest (rP = 0.722), number of node of appearance of first female flower (rP = 0.657), number of node of appearance of first male flower (rP = 0.611), duration of crop (rP = 0.508) and yield plant^{-1} (rP = 0.386).

The genotypic correlation co-efficient was found to be highly significant (at p = 0.01) and positive for number of node of appearance of first male flower with number of node of appearance of first female flower (rP = 0.939), days to first female flower (rP = 0.518), days to first harvest (rP = 0.415), number of fruits per vine (rP = 0.405), fruit length (rP = 0.401), yield plant^{-1} (rP = 0.389) and duration of crop (rP = 0.325) but it was negatively and significantly (at p = 0.01) associated with fruit set per cent (rP = -0.234), fruit diameter (rP = -0.033) and flesh thickness (rP = -0.031).

Genotypic correlation co-efficient for days to first female flower showed significant (at p = 0.01) and positive association with days to first harvest (rP = 0.758), number of node of appearance of first female flower (rP = 0.513), duration of crop (rP = 0.435) and it was negative with node to first fruit initiation (rP = -0.037).

Number of node of appearance of first female flower showed significant (at p = 0.01) and positive association with days to first harvest (rP = 0.445), duration of crop (rP = 0.356) but showed high significant (at p = 0.01) and negative association fruit set per cent (rP = -0.443).

Number of male flowers showed highly significant (at p = 0.01) and positive association with number of female flowers (rP = 0.765), fruit weight (rP = 0.688), duration of crop (rP = 0.589), yield plant^{-1} (rP = 0.579), number of fruits per vine (rP = 0.421), fruit set per cent (rP = 0.367) however, it was negatively and significantly (p = 0.01) associated with node to first fruit initiation (rP = -0.630), sex ratio (rP = -0.133).

Number of female flowers had significant and positive association with fruit weight (rP = 0.586), yield plant^{-1} (rP = 0.501), duration of crop (rP = 0.396), number of fruits per vine (rP = 0.361) at p = 0.01level, while trait fruit set per cent (rP = 0.306) was significant at p = 0.05. But it was negatively and significantly (at p = 0.01) correlated with node to first fruit initiation (rP = -0.737) and sex ratio (rP = -0.715).

The genotypic correlation co-efficient was found to be highly significant (at p = 0.01) and positive for sex ratio with node to first fruit initiation (rP =0.506) but it was negative association with fruit diameter (rP = -0.129), yield plant^{-1} (rP = -0.1568) and number of fruits per vine (rP = -0.0971).

Genotypic correlation co-efficient for node to first fruit initiation showed significant (at p = 0.05) and positive association with number of fruits per vine (rP = 0.281) and it was negatively and significantly associated with fruit weight (rP = -0.435) and flesh thickness (rP = -0.333) at p = 0.01 while, fruit set per cent (rP = -0.254) fruit diameter (rP = -0.280), duration of crop (rP = -0.314) were significant at p = 0.05.

Fruit set per cent showed highly significant (at p = 0.05) and positive association with fruit diameter (rP =0.317), flesh thickness (rP = 0.314), fruit weight (rP = 0.277) but showed negative association with rind thickness (rP = -0.013).

Days to first harvest showed positive and highly significant (at p = 0.01) genotypic correlation with duration of crop (rP = 0.749), fruit diameter (rP =0.507), flesh thickness (rP = 0.443), yield plant^{-1} (rP = 0.390), number of fruits per vine (rP = 0.387) and showed negative association with rind thickness (rP = -0.119).

The genotypic correlation co-efficient was found to be highly significant (at p = 0.01) and positive for fruit length with fruit weight (rP = 0.429), number of fruits per vine (rP = 0.329) and yield plant^{-1} (rP = 0.407) but it was negative associated with flesh thickness (rP = -0.214).

Genotypic correlation co-efficient for fruit diameter showed significant (at p = 0.01) and positive association with flesh thickness (rP = 0.958), duration of crop (rP = 0.601) and it was negative associated with number of fruits per vine (rP = -0.1235).

Rind thickness showed non-significant and positive association with number of fruits per vine (rP = 0.2006), duration of crop (rP = 0.1061), fruit weight (rP = 0.087) but showed non-significant and negative association flesh thickness (rP = -0.218),

Flesh thickness showed significant (at p = 0.01) and positive correlation with duration of crop (rP = 0.557) and it was non-significant and negative association with number of fruits per vine (rP = -0.1783) and yield plant^{-1} (rP = -0.1135).

Fruit weight showed highly significant (at p = 0.01) and positive association with yield plant^{-1} (rP = 0.770), duration of crop (rP = 0.606) and number of fruits per vine (rP = 0.451).

Number of fruits per vine had highly significant (at p = 0.01) and positive association with yield plant^{-1} (rP = 0.900) and duration of crop (rP = 0.341).

The genotypic correlation co-efficient was found to be highly significant (at p = 0.01) and positive for duration of crop with yield plant^{-1} (rP = 0.449).

4.4.2 Phenotypic Correlation

The fruit yield per plant had significant (at p = 0.01) positive association at phenotypic level with number of fruits per vine (rP = 0.881), fruit weight (rP = 0.761), number of branches vine^{-1} (rP = 0.682), number of male flowers (rP = 0.571), plant height (rP = 0.543), number of female flowers (rP = 0.495), duration of crop (rP = 0.432), fruit length (rP = 0.433), days to first harvest (rP = 0.386), number of node of appearance of first male flower (rP = 0.359), days to first male flower (rP = 0.353).

Number of leaves per vine 30 DAS, internodal length, sex ratio, fruit diameter, flesh thickness had a negative with yield.

The phenotypic correlation co-efficient was found to be highly significant (at p = 0.01) and positive for plant height with number of male flowers (rP = 0.797), number of female flowers (rP = 0.684), fruit weight (rP = 0.577), yield plant^{-1} (rP = 0.543), number of branches per vine (rP = 0.538), number of fruits per vine (rP = 0.398), fruit set per cent (rP = 0.346) at p = 0.01while, days to first harvest (rP = 0.296), duration of crop (rP = 0.292), days to first female flower(rP = 0.279) were significant at p = 0.05. But it was negatively and significantly (at p = 0.01) associated with node to first fruit initiation (rP = -0.445), number of leaves vine^{-1}at 30 DAS (rP = -0.330).

Phenotypic correlation co-efficient for number of branches per vine recorded significant (at p = 0.01) and positive association with number of fruits per vine (rP =0.659), yield plant^{-1} (rP = 0.682), number of female flowers (rP =0.537), number of male flowers (rP = 0.501), fruit weight (rP = 0.409) and it was negatively and significantly associated with sex ratio (rP = -0.358) at p = 0.01 while, inter nodal length (rP = -0.299), fruit diameter (rP = -0.252), flesh thickness (rP = -0.252) were significant at p = 0.05.

Number of leaves vine^{-1}at 30 DAS showed positive association with fruit length (rP = 0.243) and node to first fruit initiation (rP = 0.022). But it showed highly significant and negative association with days to first female flower (rP = -0.747), days to first harvest (rP = -0.668), days to first male flower (rP = -0.655), duration of crop (rP = -0.403 at p = 0.01 fruit diameter (rP = -0.314), flesh thickness (rP =-0.282*) at p = 0.05.

Table 9. Phenotypic correlation coefficients between yield and yield components

PCM	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22
X1	1																					
X2	0.538**	1																				
X3	-0.330**	0.178	1																			
X4	-0.2342	-0.299*	-0.132	1																		
X5	0.2282	-0.063	-0.655**	0.021	1																	
X6	97	0.053	-0.18	-0.138	0.564**	1																
X7	0.279*	-0.082	-0.747**	0.001	0.856**	0.465**	1															
X8	-0.1373	-0.108	-0.203	-0.046	0.587**	0.898**	0.464**	1														
X9	0.797**	0.501**	-0.199	-0.217	0.225	0.181	0.188	0.048	1													
X10	0.684**	0.537**	-0.092	-0.143	0.135	0.113	0.117	-0.001	0.753**	1												
X11	-0.192	-0.358**	-0.012	0.022	0.005	0.003	0.015	0.019	-0.126	-0.719**	1											
X12	-0.445**	-0.151	0.027	0.21	0.041	0.087	-0.032	0.097	-0.611**	-0.732**	0.517**	1										
X13	0.346**	-0.007	-0.076	0.054	0.01	-0.174	0.047	-0.371**	0.349**	0.334**	0.015	-0.245	1									
X14	0.296*	0.035	-0.668**	0.149	0.670**	0.384**	0.746**	0.412**	0.281*	0.167	0.043	0.051	0.048	1								
X15	0.11	0.135	0.24	0.025	0.105	0.384**	0.038	0.221	0.260*	0.239	0.004	-0.041	0.148	-0.117	1							
X16	0.028	-0.252*	-0.314*	0.288*	0.159	-0.033	0.250*	-0.021	0.148	0.208	-0.123	-0.271*	0.303*	0.499**	-0.193	1						
X17	-0.076	0.021	-0.084	0.051	0.162	0.004	0.166	-0.076	-0.066	-0.027	-0.074	0.198	-0.013	0.205	0.085	0.052	1					
X18	0.05	-0.252*	-0.282*	0.267*	0.108	-0.034	0.196	0.002	0.164	0.211	-0.098	-0.322*	0.299*	0.435**	-0.213	0.957**	-0.227	1				
X19	0.577**	0.409**	-0.132	-0.226	0.288*	0.166	0.214	0.002	0.683**	0.573**	-0.157	-0.421**	0.258*	0.316*	0.425**	0.174	0.092	0.143	1			
X20	0.398**	0.659**	-0.127	0.025	0.320*	0.374**	0.153	0.218	0.409**	0.351**	-0.104	0.297*	0.008	0.378**	0.322*	-0.119	0.205	-0.176	0.432**	1		
X21	0.292*	0.0219	-0.403**	0.142	0.470**	0.304*	0.425**	0.321*	0.583**	0.377**	0.035	-0.304*	0.191	0.738**	0.106	0.593**	0.101	0.549**	0.596**	0.312*	1	
X22	0.543**	0.682**	-0.1516	-0.143	0.353**	0.359**	0.233	0.175	0.571**	0.495**	-0.169	0.018	0.083	0.386**	0.433**	-0.054	0.165	-0.11	0.761**	0.881**	0.432**	1

PCM: Phenotypic correlation matrix

Inter nodal length exhibited highly significant (at p = 0.05) and positive association with fruit diameter (rP = 0.288) and flesh thickness (rP = 0.267). But negatively correlated with number of male flowers (rP = -0.217), number of female flowers (rP = -0.143), yield plant^{-1} (rP = -0.143), number of node of appearance of first female flower (rP = -0.046).

Days to first male flower had highly significant (at p = 0.01) and positive association days to first female flower (rP = 0.856), days to first harvest (rP = 0.670), number of node of appearance of first female flower (rP = 0.587), number of node of appearance of first male flower (rP = 0.564), duration of crop (rP = 0.470) and yield plant^{-1} (rP = 0.353).

The phenotypic correlation co-efficient was found to be highly significant (at p = 0.01) and positive for number of node of appearance of first male flower with number of node of appearance of first female flower (rP = 0.898), days to first female flower (rP = 0.465), days to first harvest (rP = 0.384), number of fruits per vine (rP = 0.374), fruit length (rP = 0.384), yield plant^{-1} (rP = 0.359) but it was negatively and significantly (at p = 0.01) associated with fruit set per cent (rP = -0.174), fruit diameter (rP = -0.033), flesh thickness (rP = -0.034).

Phenotypic correlation co-efficient for days to first female flower showed significant (at p = 0.01) and positive association with days to first harvest (rP = 0.746), number of node of appearance of first female flower (rP = 0.464), duration of crop (rP = 0.425) and it was negative with node to first fruit initiation (rP = -0.032).

Number of node of appearance of first female flower showed highly significant (at p = 0.01) and positive association with days to first harvest (rP = 0.412), duration of crop (rP = 0.321) but showed high significant (at p = 0.01) and negative association fruit set per cent (rP = -0.371).

Number of male flowers showed highly significant (at p = 0.01) and positive association with number of female flowers (rP = 0.753), fruit weight (rP = 0.683), duration of crop (rP = 0.583), yield plant^{-1} (rP = 0.571), number of fruits per vine (rP =

0.409), fruit set per cent (rP = 0.349) however, it was negatively and significantly (p = 0.01) associated with node to first fruit initiation (rP = -0.611).

Number of female flowers had highly significant (at p = 0.01) and positive with fruit weight (rP = 0.573), yield plant^{-1} (rP = 0.495), duration of crop (rP = 0.377), number of fruits per vine (rP = 0.351), fruit set per cent (rP = 0.334) but it was negatively and significantly (at p = 0.01) correlated with node to first fruit initiation (rP = -0.732) and sex ratio (rP = -0.719).

The phenotypic correlation co-efficient was found to be highly significant (at p = 0.01) and positive for sex ratio with node to first fruit initiation (rP = 0.517) but it was negative and non-significant association with yield plant^{-1} (rP = -0.169), fruit weight (rP = -0.157), fruit diameter (rP = -0.129), and number of fruits per vine (rP = -0.104).

Phenotypic correlation co-efficient for node to first fruit initiation showed significant (at p = 0.05) and positive association with number of fruits per vine (rP = 0.297) and it was negatively and significant associated with fruit weight (rP = -0.435) at p = 0.01 while, flesh thickness (rP = -0.322), duration of crop (rP = -0.304), fruit diameter (rP = -0.271), fruit set per cent (rP = -0.254) were significant at p = 0.05.

Fruit set per cent showed highly significant (at p = 0.05) and positive association with fruit diameter (rP =0.303), flesh thickness (rP = 0.299), fruit weight (rP = 0.258) but showed negative association with rind thickness (rP = -0.013).

Days to first harvest showed positive and highly significant (at p = 0.01) phenotypic correlation with duration of crop (rP = 0.738), fruit diameter (rP =0.499), flesh thickness (rP = 0.435), yield plant^{-1} (rP = 0.386), number of fruits per vine (rP = 0.378) and showed negative association with rind thickness (rP = -0.117).

The phenotypic correlation co-efficient was found to be significant and positive for fruit length with fruit weight (rP = 0.425), yield plant^{-1} (rP = 0.433) at p = 0.01 and number of fruits per vine (rP = 0.322) at p = 0.05. But it was negative associated with flesh thickness (rP = -0.214) and fruit diameter (rP = -0.193).

Phenotypic correlation co-efficient for fruit diameter showed significant (at p = 0.01) and positive association with flesh thickness (rP = 0.957), duration of crop (rP = 0.593) and it was negatively and non-significant associated with number of fruits per vine (rP = -0.119) and yield plant^{-1} (rP = -0.054).

Rind thickness showed non-significant and positive association with number of fruits per vine (rP = 0.205), yield plant^{-1} (rP = 0.165), duration of crop (rP = 0.101), fruit weight (rP = 0.092).

Flesh thickness showed significant (at p = 0.01) and positive correlation with duration of crop (rP = 0.549) and it was negative association with number of fruits per vine (rP = -0.176) and yield plant^{-1} (rP = -0.11).

Fruit weight showed highly significant (at p = 0.01) and positive association with yield plant^{-1} (rP = 0.761), duration of crop (rP = 0.596) and number of fruits per vine (rP = 0.432).

Number of fruits per vine had highly significant and positive association with yield plant^{-1} (rP = 0.881) at p = 0.01 and duration of crop (rP = 0.312) at p = 0.05.

The phenotypic correlation co-efficient was found to be highly significant (at p = 0.01) and positive for duration of crop with yield plant^{-1} (rP = 0.432).

4.5 PATH COEFFICIENT ANALYSIS

Genotypic correlation coefficients of yield plant^{-1} with yield contributing traits were partitioned into different components to find out the direct and indirect contribution of each character on fruit yield. Plant height, number of branches vine^{-1}, number of leaves vine^{-1} 30 at das, inter nodal length, days to first male flower, number of node of appearance of first male flower, days to first female flower, number of node of appearance of first female flower, number male flower, number of female flowers, sex ratio, fruit set, node to first fruit initiation, days to first harvest, fruit length, fruit diameter, rind thickness, flesh thickness, fruit weight, number of

Table. 10 Direct and indirect effects of yield components on fruit yield

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	X_{21}	X_{22}
X_1	**0.0228**	0.0125	-0.0078	-0.0054	0.0053	-0.0002	0.0068	-0.0035	0.0183	0.0159	-0.0045	-0.0104	0.0082	0.0069	0.0025	0.0006	-0.0018	0.0011	0.0134	0.0094	0.0067	0.5544
X_2	-0.0492	**-0.0899**	-0.0159	0.0284	0.0045	-0.0046	0.0086	0.01	-0.0457	-0.0493	0.0337	0.0136	0.0011	-0.0024	-0.0122	0.0233	-0.0018	0.0234	-0.0378	-0.0618	-0.0018	0.6931
X_3	0.0192	-0.01	**-0.0565**	0.0073	0.0401	0.011	0.0444	0.012	0.0114	0.005	0.0013	-0.0013	0.0039	0.0389	-0.0137	0.0182	0.0046	0.0165	0.0074	0.0076	0.0233	-0.156
X_4	0.0071	0.0094	0.0038	**-0.0298**	-0.0006	0.0044	-0.0005	0.0018	0.0066	0.0045	-0.0008	-0.0067	-0.0016	-0.0046	-0.0008	-0.0089	-0.0013	-0.0084	0.0069	-0.0009	-0.0043	-0.147
X_5	0.1128	-0.0244	-0.3448	0.0091	**0.4853**	0.2964	0.4588	0.3188	0.1146	0.069	0.0025	0.0137	0.0098	0.3506	0.0519	0.0845	0.0775	0.0605	0.1473	0.1555	0.2468	0.3859
X_6	0.0006	-0.0029	0.0112	0.0085	-0.0351	**-0.0574**	-0.0297	-0.0539	-0.0107	-0.0067	0.0003	-0.0052	0.0134	-0.0238	-0.023	0.0019	0.0003	0.0018	-0.0099	-0.0232	-0.0186	0.3885
X_7	-0.172	0.0549	0.4534	-0.0098	-0.5446	-0.2986	**-0.5762**	-0.2957	-0.1146	-0.073	-0.0058	0.0213	-0.0404	-0.4365	-0.0207	-0.1522	-0.1036	-0.1192	-0.1262	-0.0962	-0.2509	0.2452
X_8	-0.0159	-0.0114	-0.022	-0.0063	0.0677	0.0968	0.0529	**0.1031**	0.0056	-0.0014	0.0036	0.0106	-0.0457	0.0459	0.0249	-0.0019	-0.0121	0.0016	-0.0011	0.0236	0.0367	0.1787
X_9	-0.446	-0.2822	0.1124	0.1227	-0.1311	-0.1035	-0.1104	-0.0304	**-0.5551**	-0.4248	0.0739	0.3496	-0.2037	-0.159	-0.1443	-0.082	0.0375	-0.091	-0.3819	-0.2334	-0.3272	0.5789
X_{10}	0.0142	0.0112	-0.0018	-0.0031	0.0029	0.0024	0.0026	-0.0003	0.0156	**0.0203**	-0.0145	-0.015	0.0062	0.0035	0.005	0.0043	-0.0008	0.0045	0.0119	0.0073	0.0081	0.5008
X_{11}	-0.0873	-0.165	-0.0103	0.0121	0.0022	-0.0022	0.0044	0.0153	-0.0586	-0.3148	**0.4405**	0.2227	0.0192	0.0238	0.0005	-0.0567	-0.0294	-0.047	-0.0736	-0.0428	0.0094	-0.157
X_{12}	0.4233	0.1405	-0.0205	-0.2093	-0.0262	-0.0843	0.0343	-0.0951	0.5837	0.6828	-0.4686	**-0.9267**	0.235	-0.0491	0.0417	0.2592	-0.1908	0.3083	0.4027	-0.2601	0.2909	0.0172
X_{13}	0.0042	-0.0001	-0.0008	0.0006	0.0002	-0.0028	0.0008	-0.0052	0.0043	0.0036	0.0005	-0.003	**0.0118**	0.0007	0.0019	0.0037	-0.0002	0.0037	0.0033	0.0001	0.0025	0.0841
X_{14}	0.1038	0.0092	-0.2367	0.0531	0.2481	0.1426	0.2602	0.1529	0.0984	0.0585	0.0185	0.0182	0.0195	**0.3435**	-0.0409	0.1741	0.0629	0.1523	0.1111	0.133	0.2571	0.3897
X_{15}	-0.0014	-0.0017	-0.003	-0.0003	-0.0013	-0.0049	-0.0004	-0.003	-0.0032	-0.003	0.0002	0.0006	-0.0019	0.0015	**-0.0122**	0.0024	-0.001	0.0026	-0.0053	-0.004	-0.0013	0.4065
X_{16}	-0.0016	0.0152	0.0189	-0.0175	-0.0102	0.0019	-0.0155	0.0011	-0.0086	-0.0125	0.0075	0.0164	-0.0185	-0.0297	0.0113	**-0.0585**	-0.0041	-0.0561	-0.0102	0.0072	-0.0351	-0.068
X_{17}	-0.0104	0.0027	-0.0108	0.0057	0.0211	-0.0006	0.0238	-0.0156	-0.0089	-0.0049	-0.0088	0.0272	-0.0017	0.0242	0.0113	0.0093	**0.1321**	-0.0288	0.0115	0.0265	0.014	0.1632
X_{18}	0.0084	-0.0439	-0.0494	0.0474	0.0211	-0.0053	0.035	0.0026	0.0277	0.037	-0.018	-0.0562	0.053	0.0749	-0.0361	0.1619	-0.0368	**0.1689**	0.0247	-0.0301	0.0941	-0.114
X_{19}	0.2814	0.202	-0.0629	-0.1107	0.1456	0.0832	0.1052	-0.0052	0.3302	0.2814	-0.0802	-0.2086	0.1331	0.1553	0.2058	0.084	0.0419	0.0701	**0.4799**	0.2163	0.2908	0.7701
X_{20}	0.5258	0.88	-0.1716	0.0404	0.4102	0.5181	0.2138	0.2925	0.5382	0.4623	-0.1243	0.3592	0.0156	0.4956	0.4206	-0.1581	0.2568	-0.2282	0.5768	**1.2799**	0.4358	0.8999
X_{21}	-0.1855	-0.0129	0.2588	-0.0899	-0.3194	-0.2041	-0.2736	-0.2237	-0.3703	-0.2491	-0.0134	0.1972	-0.1322	-0.4703	-0.067	-0.3773	-0.0666	-0.35	-0.3807	-0.2139	**-0.6283**	0.4487

Residual effect = 0.122

Plant height (X_1), number of branches vine-^{1} (X_2), number of leaves vine^{-1}at 30 DAS (X_3), inter nodal length (X_4), days to first male flower(X_5), number of node of appearance of first male flower (X_6), days to first female flower(X_7), number of node of appearance of first female flower(X_8), number of male flowers (X_9), number of female flowers (X_{10}), sex ratio (X_{11}), node to first fruit initiation (X_{12}), fruit set present (X_{13}), days to first harvest (X_{14}), fruit length (X_{15}), fruit diameter (X_{16}), rind thickness (X_{17}), flesh thickness (X_{18}), fruit weight (X_{19}), number of fruits per vine (X_{20}), duration of crop (X_{21}) and yield plant^{-1} (X_{22}).

fruits per vine**,** duration of crop and yield plant^{-1} was selected for path coefficient analysis in bottle gourd. The results are noted in Table 10.

The analysis data recorded that yield plant^{-1} showed the highest positive direct effect on number of fruits per vine (1.2799) followed by days to first male flower (0.4853), fruit weight (0.4799), sex ratio (0.4405), days to first harvest (0.3435), flesh thickness (0.1689), rind thickness (0.1321), number of node of appearance of first female flower (0.1031), plant height (0.0228), number of female flowers (0.0203), fruit set (0.0118). Whereas, node to first fruit initiation (-0.9267), duration of crop (-0.6283), days to first female flower (-0.5762), number of male flowers (-0.5551), number of branches vine-^{1} (-0.0899), fruit diameter (-0.0585), number of node of appearance of first male flower (-0.0574), number of leaves vine^{-1} at 30 DAS (-0.0565), internodal length (-0.0298) and fruit length (-0.0122) showed negative direct effects on yield plant^{-1}.

Plant height (X_1), number of branches vine-^{1} (X_2), number of leaves vine^{-1}at 30 DAS (X_3), internodal length (X_4), days to first male flower (X_5), number of node of appearance of first male flower (X_6), days to first female flower (X_7), number of node of appearance of first female flower (X_8), number of male flowers (X_9), number of female flowers (X_{10}), sex ratio (X_{11}), node to first fruit initiation (X_{12}), fruit set (X_{13}), days to first harvest (X_{14}), fruit length (X_{15}), fruit diameter (X_{16}), rind thickness (X_{17}), flesh thickness (X_{18}), fruit weight (X_{19}), number of fruits per vine (X_{20}), duration of crop (X_{21}) and yield plant^{-1} (X_{22}).

Plant height showed the positive direct effect (0.0228) on yield. The trait also showed the maximum positive indirect effect through, number of male flowers (0.0183), number of female flowers (0.0159), fruit weight (0.0134), number of branches vine-^{1} (0.0125), number of fruits per vine (0.0094), duration of crop (0.0067) and negatively through internodal length (-0.0054), sex ratio (-0.0045) and number of node of appearance of first female flower (-0.0035).

Number of branches vine^{-1} showed the negative direct effect (-0.0899) on yield. This trait also showed high positive indirect effect through sex ratio (0.0337), internodal length (0.0284), flesh thickness (0.0234), fruit diameter (0.0233), fruit set per cent (0.001), number of node of appearance of first female flower (0.01), days to first female flower (0.0086), days to first male flower (0.0045). But the negative indirect effect through number of fruits per vine (-0.0618), number of female flowers (-0.0493), plant height (-0.0492), number male flower (-0.0457), fruit weight (-0.0378), duration of the crop (-0.0018).

Number of leaves vine^{-1} 30 at DAS showed a negative direct effect (-0.0565) on yield. This trait showed positive indirect effect through days to first male flower (0.0045), days to first harvest (0.0389), duration of crop (0.0233), fruit diameter (0.0182), flesh thickness (0.0165), number of node of appearance of first female flower (0.012), number male flower (0.0114), number of node of appearance of first male flower (0.011), number of fruits per vine (0.0162), internodal length (0.0284), fruit weight (0.0074), number of female flowers (0.005). But negative indirect effect through fruit length (-0.0137), number of branches vine^{-1} (-0.01).

Internodal length showed a negative direct effect (-0.0298) on yield. This trait, however, showed positive indirect effect through the number of branches vine^{-1} (0.0094), plant height (0.0071), fruit weight (0.0069), number male flower (0.0066), number of female flowers (0.0045), number of node of appearance of first male flower (0.0044), number of node of appearance of first female flower (0.0018). The negative indirect effects were also observed via fruit diameter (-0.0089), followed by flesh thickness (-0.0084), fruit set (-0.0067), days to first harvest (-0.0046), duration of the crop (-0.0043) number of fruits per vine (-0.0009), sex ratio (-0.0008).

Days to first male flower showed positively direct effect (0.4853) on yield. This trait, however, showed positive indirect effect through plant height (0.1128), days to first female flower (0.4588), first harvest (0.3506), number of node of appearance of first female flower (0.3188), number of node of appearance of first male flower (0.2964), duration of crop (0.2468), number of fruits per vine (0.1555), fruit weight (0.1473), number of male flowers (0.1146), number of female flowers (0.069), sex ratio (0.0025). The negative indirect effect via number of leaves vine^{-1}at 30 DAS (-0.3448) followed by number of branches vine-^{1} (-0.0244).

Number of node of appearance of first male flower showed a negative direct effect (-0.0574) on yield. This trait also showed the highest positive indirect effect through fruit set (0.0134), number of leaves vine^{-1} at 30 DAS (0.0112), fruit diameter (0.0019), flesh thickness (0.0018) and internodal length (0.0085). The trait also produced the negative indirect effect on yield via number of node of appearance of first female flower (-0.0539), days to first male flower (-0.0351), days to first female flower (-0.0297), number of fruits per vine (-0.0232) and fruit length (-0.023).

It was found that days to first female flower showed negative direct effect (-0.5762) on yield. The trait showed the maximum positive indirect effect through number of leaves vine^{-1} 30 at DAS (0.4534), number of branches vine^{-1} (0.0549). The negative indirect effect of this trait on yield via days to first male flower (-0.5446) was the highest followed by days to first harvest (-0.4365), number of node of appearance of first male flower (-0.2986), number of node of appearance of first female flower (-0.2957), duration of crop (-0.2509) and fruit weight (-0.1262).

Number of node of appearance of first female flower showed a positive direct effect (0.1031) on yield. This trait, also showed the highest positive indirect effect through number of node of appearance of first male flower (0.0968), days to first male flower (0.0677), days to first female flower (0.0529), days to first harvest (0.0459), duration of crop (0.0367), fruit length (0.0249), number of fruits per vine (0.0236), The trait also produced a negative indirect effect on yield via fruit set per cent (-0.0457) and sex ratio (-0.0014).

Number of male flowers showed a negative direct effect (-0.5551) on yield. This trait, however, showed also positive indirect effect through the node to first fruit initiation (0.3496), number of branches vine-^{1} (0.1227) and number of leaves vine^{-1}at 30 DAS (0.1124). The negative indirect effects were also observed via plant height (-0.446) followed by the number of female flowers (-0.4248), number of fruits per vine (-0.3819) and fruit length (-0.1443).

Number of female flowers produced a positive direct effect (0.0203) on yield. The character, however, showed also some positive indirect effect through plant height (0.0142), fruit weight (0.0119), number of branches vine-^{1} (0.0112), duration of crop (0.0081), number of fruits per vine (0.0073), fruit set per cent (0.0062), fruit length (0.005).The negative indirect effects were also observed via internodal length (-0.0031), sex ratio (-0.0145) and node to first fruit initiation (-0.015).

Sex ratio flower showed a positive direct effect (0.4405) on yield. This character, however, showed also positive indirect effect through node to first fruit initiation (0.2227), days to first harvest (0.0238), fruit set per cent (0.0192), internodal length (0.0121), number of node of appearance of first female flower (0.0153), days to first female flower (0.0044), days to first male flower (0.0022). The negative indirect effects were also observed via number of female flowers (-0.3148), number of branches vine-^{1} (-0.165), plant height (-0.0873), fruit weight (-0.0736), flesh thickness (-0.047) and fruit diameter (-0.0567).

Node to first fruit initiation showed a negative direct effect (-0.9267) on yield. This trait also showed the highest positive indirect effect through number of female flowers (0.6828), number of male flowers (0.5837), plant height (0.4233), fruit weight (0.4027), flesh thickness (0.3083), duration of crop (0.2909), fruit diameter (0.2592), number of branches vine-^{1} (0.1405). The trait also produced a negative indirect effect on yield via sex ratio (-0.4686), number of fruits per vine (-0.2601), internodal length (-0.2093) and number of node of appearance of first male flower (-0.0843).

It was found that fruit set per cent showed the positive direct effect (0.0118) on yield. The trait also showed the maximum positive indirect effect through a number of male flowers (0.0043), plant height (0.0042), fruit diameter (0.0037), number of female flowers (0.0036), duration of crop (0.0025), sex ratio (0.0005). The negative indirect effect of this trait on yield via number of node of appearance of first female flower (-0.0052), node to first fruit initiation (-0.003) and number of node of appearance of first male flower (-0.0028).

Days to first harvest had a positive direct effect (0.3435) on yield. This trait also showed positive indirect effect through days to first female flower (0.2602), duration of crop (0.2571), days to first male flower (0.2481), fruit diameter (0.1741), flesh thickness (0.1523), number of node of appearance of first male flower (0.1426), number of fruits per vine (0.133), fruit weight (0.1111), plant height (0.1038), internodal length (0.0531) but negative indirect effect through fruit length (-0.0409) and number of leaves vine^{-1} at 30 DAS (-0.2367).

It was found that fruit length showed the negative direct effect (-0.0122) on yield. The trait also showed the maximum positive indirect effect through flesh thickness (0.0026), fruit diameter (0.0024), days to first harvest (0.0015), and sex ratio (0.0002). The negative indirect effect of this trait on yield via fruit weight (-0.0053), number of node of appearance of first male flower (-0.0049), number of male flowers (-0.0032), number of fruits per vine (-0.004) and plant height (-0.0014).

Fruit diameter showed a negative direct effect (-0.0585) on yield. This trait also showed the highest positive indirect effect through number of leaves vine^{-1}at 30 DAS (0.0189), fruit set (-0.0185), node to first fruit initiation (0.0164), number of branches vine-^{1} (0.0152), fruit length (0.0113), number of fruits per vine (0.0072). The trait also produced a negative indirect effect on yield via flesh thickness (-0.0561), rind thickness (-0.0041), duration of crop (-0.0351), internodal length (-0.0175) and fruit weight (-0.0102).

Rind thickness showed a positive direct effect (0.1321) on yield. This trait also showed the highest positive indirect effect through node to first fruit initiation (0.0272), number of fruits per vine (0.0265), days to first harvest (0.0242), days to first male flower (0.0211), fruit weight (0.0115), duration of crop (0.014), fruit length (0.0113), fruit diameter (0.0093), number of branches vine-^{1} (0.0027). The trait also produced a negative indirect effect on yield via flesh thickness (-0.0288), plant height (-0.0104), sex ratio (-0.0088), number of male flowers (-0.0089) and fruit set per cent (-0.0017).

It was found that flesh thickness showed a positive direct effect (0.1689) on yield. The trait also showed the maximum positive indirect effect through fruit diameter (0.1619), duration of crop (0.0941), days to first harvest (0.0749), fruit set (0.053), internodal length (0.0474), number of female flowers (0.037), days to first female flower (0.035), fruit weight (0.0247), number of male flowers (0.0277).The negative indirect effect of this trait on yield via node to first fruit initiation (-0.0562), number of node of appearance of first male flower (-0.0053), number of leaves vine^{-1}at 30 DAS (-0.0494), number of branches vine-^{1} (-0.0439), rind thickness (-0.0368), fruit length (-0.0361) and number of fruits per vine (-0.0301),

Fruit weight showed a positive direct effect (0.4799) on yield. This trait also showed the highest positive indirect effect through number of male flowers (0.3302),duration of crop (0.2908), number of female flowers (0.2814), plant height (0.2814), fruit length (0.2058), number of branches vine^{-1} (0.202), node to first fruit initiation (0.2163), days to first harvest (0.1553), fruit set per cent (0.1331) days to first female flower (0.1052), fruit diameter (0.084), number of node of appearance of first male flower (0.0832), rind thickness (0.0419). The trait also produced a negative indirect effect on yield via node to first fruit initiation (-0.2086), internodal length (-0.1107), sex ratio (-0.0802) and number of node of appearance of first female flower (-0.0052).

Number of fruits per vine showed a positive direct effect (1.2799) on yield. This trait also showed the highest positive indirect effect through number of branches vine-^{1} (0.88), fruit weight (0.5768), number of male flowers (0.5382), plant height (0.5258), number of node of appearance of first male flower (0.5181), days to first harvest (0.4956), duration of crop (0.4358), number of female flowers (0.4623), fruit length (0.4206), days to first male flower (0.4102), node to first fruit initiation (0.3592), number of node of appearance of first female flower (0.2925), rind thickness (0.2568), days to first female flower (0.2138). The trait also produced a negative indirect effect on yield via flesh thickness (-0.2282), fruit diameter (-0.1581) and sex ratio (-0.1243).

It was found that the duration of crop showed the negative direct effect (-0.6283) on yield. The trait also showed the maximum positive indirect effect through number of leaves vine^{-1}at 30 DAS (0.2588), node to first fruit initiation (0.1972). The negative indirect effect of this trait on yield via days to first harvest (-0.4703), fruit weight (-0.3807), fruit diameter (-0.3773), number of male flowers (-0.3703), days to first male flower (-0.3194), days to first female flower (-0.2736), plant height (-0.1855) and number of branches vine-^{1}(-0.0129).

4.6 SELECTION INDEX

Discriminant function analysis was adopted for the construction of the selection index. Selection index was computed based on characters *viz.*, plant height, days to first female flower, number of node of appearance of first female flower, number of female flowers, sex ratio, fruit set per cent, days to first harvest, rind thickness, flesh thickness, fruit weight, number of fruits per vine and yield plant^{-1}. The index score for each treatment was determined and they were ranked. The score obtained for the treatments based on the selection index are given in Table 11.

Based on the selection index, IC 536593 ranked first with a score of 2548.189 followed by Tvpm Local (2474.530), Pant Lauki-4 (2372.989) and Arka Bahar (1758.896). Minimum score was recorded in BG-3 (644.296)

Table 11. Bottle gourd genotypes ranked according to selection

Treatments		Selection index score	Rank
T1	**Arka Bahar**	1758.896	28
T2	**Pusa Naveen**	2322.691	5
T3	**Pant lauki-1**	2369.843	4
T4	**Pant lauki-4**	2372.989	3
T5	**Samrat**	1998.136	20
T6	**BG-12**	2212.692	9
T7	**KAR -1**	1717.433	29
T8	**BG-8**	2372.989	7
T9	**BG-11**	1907.463	25
T10	**IC146312**	2247.174	6
T11	**Tvpm Local**	2474.530	2
T12	**IC 334300**	2007.096	18
T13	**IC284891**	1914.811	24
T14	**IC284895**	2134.703	12
T15	**IC311135**	1903.119	26
T16	**IC339196**	1639.094	30
T17	**IC 331101**	2015.172	17
T18	**IC 371745**	2209.018	10
T19	**BG-13**	2001.184	19
T20	**IC 536593**	2548.189	1
T21	**IC 538142**	1984.073	21
T22	**IC342077**	2070.874	15
T23	**IC417704**	2115.327	13
T24	**IC398545**	2063.916	16
T25	**KS - 1**	1944.407	22
T26	**IC343153**	2221.643	8
T27	**BG-1**	2094.528	14
T28	**BG-2**	1846.077	27
T29	**BG-3**	644.296	31
T30	**Naveen**	2191.906	11
T31	**BG-6**	1917.731	23

DISCUSSION

5. DISCUSSION

The present investigation was carried out at the Department of Vegetable Science, College of Agriculture, Vellayani, during 2019-2020 to evaluate the performance of bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] genotypes for growth, yield and quality characteristics. The extent of variability in important characters, genetic advance under selection and correlations among the traits were assessed. The salient results of the present investigation are discussed under the following headings.

5.1 Mean performance of accessions/genotypes

5.2 Coefficient of variation (CV)

5.3 Heritability and genetic advance

5.4 Correlation analysis

5.1 MEAN PERFORMANCE OF VARIETIES/ GENOTYPES/ HYBRIDS

5.1.1 Vegetative Characters

In the present field study, significant variation was observed for all the vegetative traits *viz.* plant height (m), number of branches vine^{-1}, number of leaves vine^{-1} at 30 DAS and internodal length.

Longest vine length was recorded by Tvpm Local (10.94 m) and shortest by BG-3 (2.69 m). The significant variation in plant height might be due to the specific genetic makeup of different accessions, inherent properties and vigour of the corp. Vine length is considered a significant yield contributing trait because it leads to a greater number of branches and ultimately results in increased productivity. These are in conformity with the results of Vittal (2016) in bottle gourd.

There was statistically significant difference among the genotypes for the number of branches vine^{-1} with a mean range of 2.9 in the accession BG-3 to 9.2 in the Tvpm Local. Similar genotypic variations in the number of branches vine^{-1} was also reported by Harika *et al.* (2012) and Tirumalesh and Mandal (2018) in bottle gourd which might be attributed to the specific genetic constitution and the vigour of different genotypes.

In the present study, the number of leaves vine^{-1} at 30 DAS. The highest number of leaves was noticed in BG-6 (22.8) which was at par with BG-13 (22.7). Arka Bahar recorded for lowest (10.6). Higher the vine length of plant might have led to the production of a greater number of branches and bears the greater number of leaves. A similar range of results was recorded by Kabir (2010) and Haque *et al*. (2009) in bottle gourd and Singh *et al*. (2013) and Reddy *et al.* (2013) in ridge gourd.

There were statistically significant differences among the accessions for internodal length with a mean range of 17 cm in the accession IC 536593 to 21.8 cm in the IC 538142. Similar range of variation in internodal length was reported by Kabir (2010) and Kalyanrao *et al*. (2016) in bottle gourd and Choudhary *et al.* (2014) in ridge gourd. Highest vine length resulting in highest internodal length might be due to the diversion of the higher quantity of metabolites for exhibiting high vegetative vigour as reported in wild melon by Ganiger *et al*. (2014).

5.1.2 ***Flowering Parameters***

Statistically significant differences were noticed among the genotypes for flowering traits *viz.* days to first male flower, number of node of appearance of first male flower, days to first female flower, number of node of appearance of first female flower, number of male flowers, number of female flowers and sex ratio (M/F).

In the present study, earlier male flower production was noticed in BG-1 (41.2 days) which was at par with BG-2 (41.3 days). IC 536593 recorded for late male flower production (51.5 days). Early production of male flowers on the vine is an indication of crop earliness. A similar range of results were observed in bottle gourd for days taken to male flower production by Harika *et al.* (2012), Tirumalesh *et al.* (2016), Kunjam (2018) and Kandasamy *et al.* (2019).

There were statistically significant differences among the accessions for the number of node of appearance of first male flower with a mean range of 6.1 in the accession BG-6 to 14.5 in IC398545. The node at which first male flower appears play a significant role in determining the total number of male flowers. A similar range variation in the number of node of appearance of first male flower were reported by Harika *et al.* (2012), Tirumalesh *et al.* (2016) and Kandasamy *et al.* (2019).

In the present study, days to first female flower production was noticed in BG-2 (44.3 days) which was at par with BG-6 (46.6 days). IC 536593 was late to produce female flower (57.2 days). An early appearance of female flowers on the vine is an indication of crop earliness and the information regarding earliness help in development location specific early or late cultivars. A similar range of observation was recorded by Harika *et al.* (2012), Ciba and Syamala (2017), Rambabu *et al*. (2017), Kunjam (2018) and Kandasamy *et al.* (2019) in bottle gourd.

The lowest number of node at which the first female flower initiated was recorded in BG-6 (9.3) and highest in IC398545 (16.7). These are in conformity with studies of Dubey and Maurya (2007), Visen *et al.* (2014), Ciba and Syamala (2017), Chouhan (2017) and Pandiyan *et al.* (2019) in bottle gourd.

There was statistically significant difference among the accessions for the number of male flowers. That ranged from 46.9 in the accession BG-3 to 146.5 in the accession Tvpm Local with overall treatment mean 128.3. A similar range was reported by Shinde *et al.* (2014) and Vittal (2016) in bottle gourd.

The highest number of female flowers was recorded by accession IC342077 (22.1) and lowest by BG-3 (5.3). These are in conformity with the studies of Kabir (2010) and Tirumalesh *et al.* (2016) in bottle gourd.

In the present study, the lowest sex ratio was noticed in IC342077 (5.96) which was at par with Tvpm Local (7.4). IC 334300 recorded the highest sex ratio (11.75). This variation in sex ratio might be due to genetic composition of genotypes. Similar range of observations was recorded by Harika *et al*. (2012) Sharma and Sengupta (2013) and Uddin *et al*. (2014) and Patle *et al.* (2018) in bottle gourd.

5.1.3 ***Fruit Yield Parameter***

A significant difference was noticed among the genotypes for fruit yield traits like node to first fruit initiation, fruit set (%), days to first harvest, fruit skin colour, fruit shape, fruit length (cm), fruit diameter (cm), rind thickness (mm), flesh thickness (cm), fruit weight (g), number of fruits per vine, yield plant^{-1} (kg), yield plot^{-1} (kg) and duration of crop (days).

There was statistically significant difference among the accessions for node to first fruit initiation with a mean range of 13.7 in the accession BG-3 to 19.4 in the accession IC342077 with overall treatment mean 16.42. The similar range was recorded by Kalyanrao *et al*. (2016) in bottle gourd.

Highest fruit set (%) was recorded by accession BG-3 (43.3%) and lowest by IC342077 (13.2%). This variation might be due to genetic constitution of genotypes. The similar range of results was recorded by Tomar *et al.* (2015) and Kalyanrao *et al*. (2016) in bottle gourd.

There was a statistically significant difference among the accessions for days to first harvest with a mean range of 57.8 in the accession BG-2 to 74.1 in the IC284891. Similar range variation in days to first harvest was reported by Harika *et al.* (2012), Visen *et al.* (2014), Chouwan (2017) and Kunjam (2018) in Bottle gourd and Nisha (2017) in watermelon.

In the present study, varied fruit skin colour was noticed in 31 accessions among them 16 accessions *viz.* Arka Bahar, Pant Lauki-1, Pant Lauki-4, Samrat, BG-12, Tvpm Local, IC 334300, IC311135, IC339196, BG-13, IC342077, IC343153, BG-1, BG-2, Naveen and BG-8 were noted for light green fruit skin colour, 12 accessions *viz.* Pusa Naveen, KAR-1, IC 146312, IC284891, IC284895, IC 331101, IC 371745, IC 536593, IC 538142, IC417704, IC398545, BG-8 and BG-11 for green fruit skin colour, and the remaining three accessions *viz*. KS-1, IC417704 and BG-3 were noted for patchy dark green fruit skin colour. A similar range of observation was recorded by Vittal (2016), Chouwan (2017), Rambabu *et al.* (2017) and Kunjam (2018) in bottle gourd.

Among the thirty-one accessions, twelve accessions *viz.*, IC284891, IC339196, IC 331101, IC 536593, IC342077, IC398545, KS-1, IC343153, BG-1, BG-3, BG-6 and

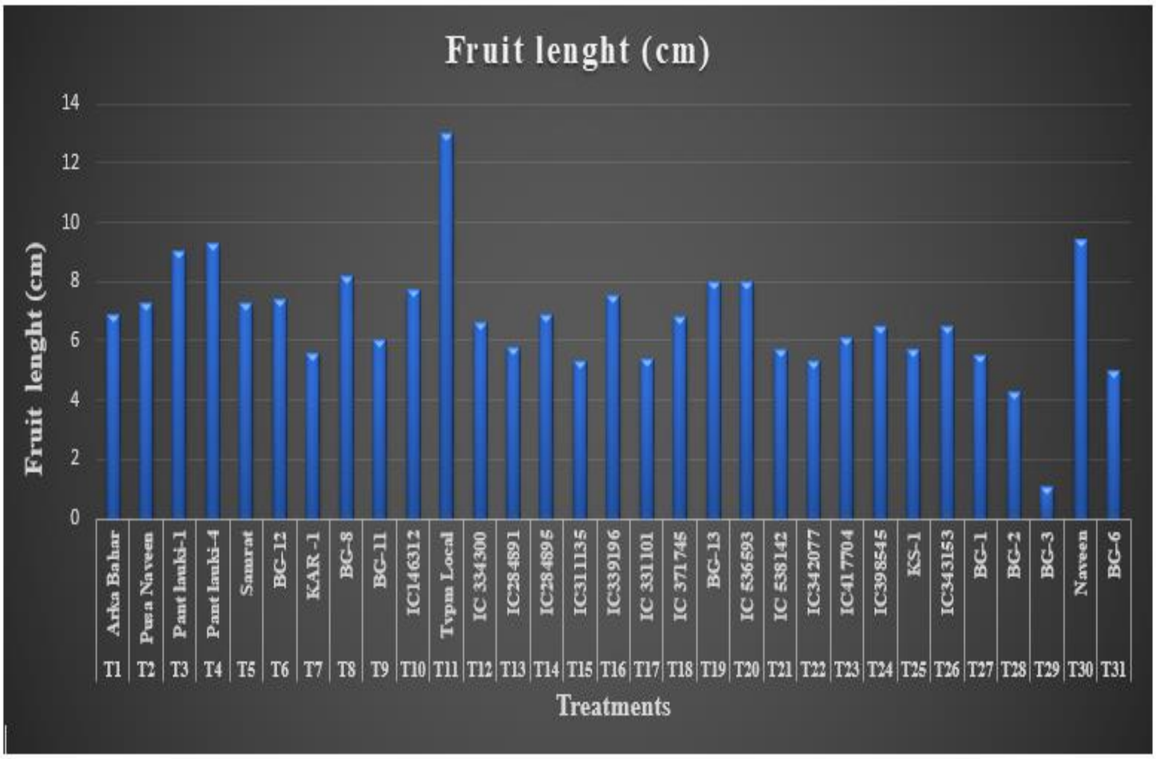


Fig 2. Mean performance of genotypes for fruit lenght (cm)

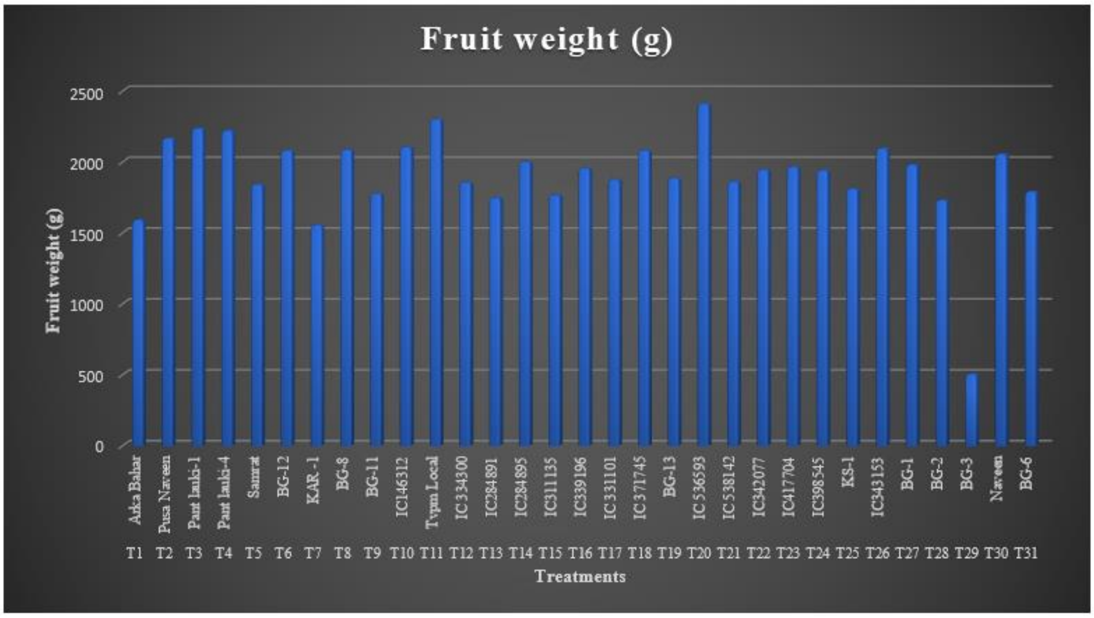


Fig 3. Mean performance of genotypes for fruit weight (kg)

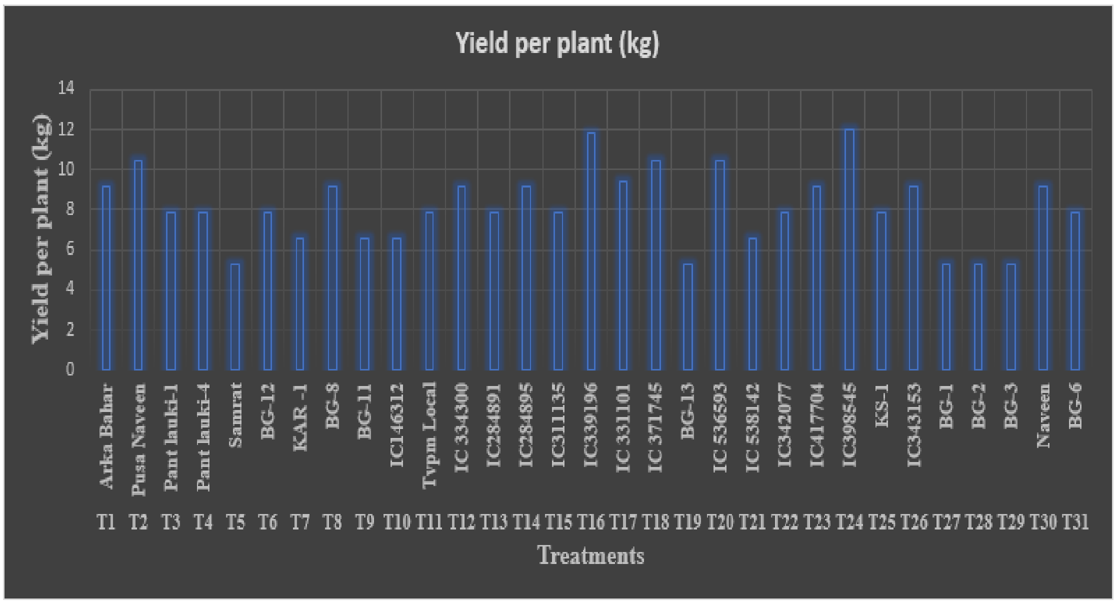


Fig 4. Mean performance of genotypes for yield per plant (kg)

BG-8 produced elongate curved fruit shape, eleven accessions *viz.,* Arka Bahar, IC146312, Tvpm Local, IC334300, IC284895, IC311135, IC 371745, BG-13, IC 538142, BG-2 and BG-11 produced elongate straight shaped fruits, while remaining eight accessions *viz.*, Pusa Naveen, Pant Lauki-1, Pant Lauki-4, Samrat, BG-12, KAR-1, IC417704, IC 371745 and Naveen produced cylindrical-shaped fruits. A similar range of observation was recorded by Morimoto *et al.* (2005), Achigan-Dako *et al.* (2008), Yetisir *et al.* (2008), Xu *et al.* (2014), Gurcan *et al*. (2015), Chouwan (2017), Rambabu *et al.* (2017) and Kunjam (2018) in bottle gourd.

Maximum fruit length was observed in IC 371745 (68.8 cm) and minimum in BG-3 (22.9 cm). Kumar *et al*. (2018) reported that fruit length directly contributes to the fruit weight, thus affecting the yield per vine. A significant difference in the fruit length may be due to the genetic composition of the accession. These findings were supported by Visen *et al.* (2014), Kalyanrao *et al*. (2016) and Kandasamy *et al.* (2019) in bottle gourd.

There was a statistically significant difference among the accessions for fruit diameter with a mean range of 7.35 cm in the accession BG-1 and Naveen to 15.97 cm in the IC417704. Rathore *et al.* (2017) reported that significant variations in fruit diameter might be due to fruit length and number of fruits per vine in ridge gourd. A similar range of variation in fruit diameter was reported by Kunjam (2018), Kandasamy *et al.* (2019) and Pandiyan *et al.* (2019).

Variation in rind thickness among these accessions indicate the possibility of selection among genotypes for desired rind thickness. Highest rind thickness was observed in IC 538142 (3.79 mm) and lowest in IC 331101 (1.69 mm). Significant difference in the rind thickness might be due to the genetic composition of the accession. These findings were supported by Chaudhary and Singh (1981), Sharma *et al.* (1997), Harika *et al.* (2012) and Vittal (2016) in bottle gourd.

There was statistically significant difference among the accessions for flesh thickness with a mean range of 4.19 cm in the accession Naveen to 12.56 cm in the

IC417704. Harika *et al.* (2012) observed similar range of variation in flesh thickness and reported that differences in flesh thickness could be attributed to the inherent traits of cultivars and flesh thickness increases with an increase in size of the fruit.

In the present study, fruit weight was noticed in IC 536593 (2410 g) which was at par with Tvpm Local (2300 g). BG-3 recorded the lowest fruit weight (11.75). A similar observations were recorded by Wani *et al.* (2008), Deepthi *et al* (2016), Kalyanrao *et al*. (2016) and Kandasamy *et al.* (2019) in bottle gourd.

Highest number of fruits per vine was observed in Tvpm Local (6) and least in BG-3 (2.3). It may be due to differences in sex ration, fruit set per cent and genetic composition of genotypes. These findings were supported by Kalyanrao *et al*. (2016), Rambabu *et al.* (2017), Kumar *et al.* (2018) and Tirumalesh and Mandaland (2018) in bottle gourd.

There was statistically significant difference among the accessions for yield plant^{-1} with a mean range of 1.1 kg in the accession BG-3 to 13 kg in the Tvpm Local. Higher yield per plant in Tvpm Local is due to its better performance in fruit set per cent (30.3 %), number of fruits per vine (6), fruit weight (2300 kg), fruit length (52.1 cm) and fruit diameter (8.58). Rao *et al*., (2000) reported that the genotypes with longer vine length give a higher yield per vine. These results are in confirmation with studies of Harika *et al.* (2012), Deepthi *et al* (2016), Vittal (2016), Tirumalesh and Mandaland (2018) and Pandiyan *et al.* (2019) in bottle gourd.

Highest yield per plot was recorded by accession Tvpm Local (197.9 kg) because of its better performance in fruit set per cent (30.3 %), number of fruits per vine (6), fruit weight (2300 kg), fruit length (52.1 cm) and fruit diameter (8.58). Lowest yield per plot was in BG-3 (17.3 kg). Similar range of result was confirmed with Visen *et al*. (2014) and Vittal (2016) in bottle gourd.

Maximum crop duration was observed in IC417704 (137.2 days) and minimum in BG-3 (99.9 days). The significant difference in the crop duration might be due to the genetic composition of the accession. A similar range of observations was recorded by Deepthi *et al* (2016), Kalyanrao *et al*. (2016) and Kunjam (2018) in bottle gourd.

5.1.3 Biochemical Parameters

A significant difference was noticed among the genotypes for the biochemical traits like T.S.S. (^{0}Brix), ascorbic acid content of the pulp (mg/100g), dry matter content (%), crude fiber content (g/100g), potassium(K) content of the pulp (mg/100 g), calcium (Ca) content of the pulp (mg/100 g).

There was statistically significant difference among the accessions for TSS (^{0}Brix). That ranged from 1.5° B in the accession Pusa Naveen to 2.5° B in the BG-3. A similar range variation in T.S.S. (^{0}Brix) was reported by Harika *et al.* (2012), Sahu *et al.* (2015), Ilyas *et al*. (2017) and Rambabu *et al.* (2017) in bottle gourd.

The highest ascorbic acid content of the pulp was recorded by accession IC398545 (12.0 mg/100g) and lowest by IC398545 (5.26 mg/100g). Similar result was obtained by Rambabu *et al.* (2017) and Iqbal *et al.* (2019) in bottle gourd.

In the present study, dry matter content was noticed in BG-3 (6.71 %) which was at par with KAR-1 (5.93 %). IC 334300 had recorded the lowest fruit dry matter (2.18 %). Chandanshive (2003) recorded similar range in different gourds.

Highest crude fiber content was observed in IC417704 (27.2 g/100g) and least in BG-3 (18.2 g/100g). Similar range of observation was recorded by Bello *et al.* (2014) in bottle gourd.

Among the accessions the potassium content of the pulp was ranged from from 2125 mg/100g in BG-3 to 3125mg/100g in IC417704. Similar variation in potassium content of the pulp was reported by Parle and Kaur (2011) and Gajera *et al.* (2017) in bottle gourd.

Highest calcium (Ca) content of the pulp was recorded by accession IC417704 (1600 mg/100 g) and lowest by BG-3 (1050 mg/100 g). Similar range result was confirmed with Sithole *et al.* (2015) in bottle gourd crop.

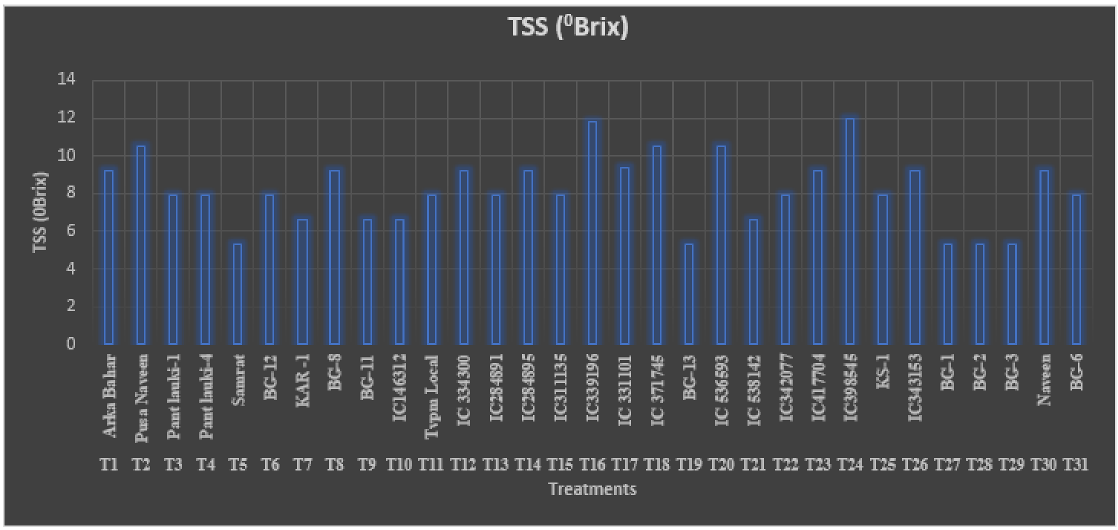


Fig 5. Mean performance of genotypes for TSS (^{0}Brix)

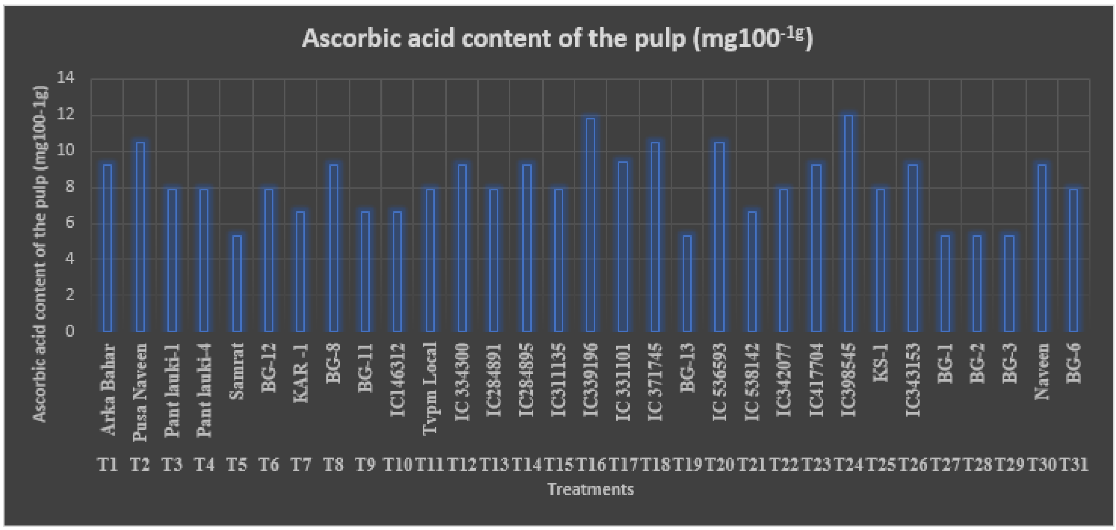


Fig 6. Mean performance of genotypes for ascorbic acid content of the pulp (mg 100^{-1}g)

5.2 COEFFICIENT OF VARIATION (CV)

The degree of variability present in germplasm is of supreme importance as it provides the basis for effective selection. The phenotypic coefficient variation (PCV) and genotypic coefficients variation (GCV) are the components used to measure the variability present in germplasm. In the present study, even though the phenotypic coefficient of variation was higher than the corresponding genotypic coefficient of variation for all the traits, only a small variance was observed among PCV and GCV. This revealed greater stability of the characters against environmental instability, thus making a selection based on phenotypic performance reliable. A major portion of PCV was contributed by GCV for most of the traits suggesting that the observed variation was mainly due to genetic factors. This similarity between PCV and GCV were reported earlier by Ram *et al.* (2007), Husna (2009), Pandit (2009), Sharma and Sengupta (2013), Deepthi *et al*. (2016), Chouwan (2017), Rani and Reddy (2017), Singh *et al.* (2017), Kunjam (2018), Panigrahi and Duhan (2018), Rana *et al.* (2018), Kunjan (2018) and Rambabu (2017).

High GCV and PCV were recorded for plant height, number of branches vine^{-1}, number of female flowers, fruit set (%), fruit length, flesh thickness, yield per plant, yield per plot, ascorbic acid content of the pulp, dry matter content clearly indicating that selection will be rewarding for the traits. These results are in agreement with the findings of Sharma and Sengupta (2013), Deepthi *et al*. (2016), Rani and Reddy (2017), Kunjam (2018), Panigrahi and Duhan (2018), Rambabu (2017), Rana *et al.* (2018) and Sultana *et al.* (2018) in bottle gourd.

Moderate PCV and GCV were recorded for the number of node of appearance of first male flower, days to first female flower, number of node of appearance of first female flower, number male flower, Sex ratio (%), fruit diameter, rind thickness, fruit weight, TSS, calcium content of the pulp. Similar results were reported by Sharma and Sengupta (2013), Deepthi *et al*. (2016), Rani and Reddy (2017), Kunjam (2018), Panigrahi and Duhan (2018), Rambabu (2017) and Rana *et al.* (2018) in bottle gourd. Low GCV and PCV were recorded for inter nodal length, days to first male flower, node to first fruit initiation, days to first harvest, duration of crop, crude fibre content, potassium content of the pulp. Similar results were reported by Sharma and Sengupta (2013), Deepthi *et al*. (2016), Rani and Reddy (2017), Kunjam (2018), Panigrahi and Duhan (2018), Rambabu (2017), Rana *et al.* (2018) and Sultana *et al.* (2018) in bottle gourd.

5.3 HERITABILITY AND GENETIC ADVANCE

The genotypic coefficient of variation (GCV) does not offer full scope to estimate the variation that is heritable and therefore, the estimation of heritability becomes necessary. The knowledge of heritability along with genetic advance aid in drawing valuable conclusions for effective selection based on phenotypic performance (Johnson *et al.*, 1955).

In the present investigation, high heritability was observed for all the traits studied. The degree of heritability ranged from 64.32 to 99.82 (%). Highest heritability was recorded for number of male flowers (99.82 %), yield plot^{-1} (99.8 %), fruit length (99.70 %), fruit diameter (98.79 %), plant height (98.21 %), flesh thickness (97.82 %), fruit weight (96.88 %), dry matter content (96.09 %), duration of crop (95.97 %), crude fiber content (95.55 %), days to first harvest (95.32 %), yield plant^{-1} (95.12 %), number of branches vine-^{1} (94.49 %), potassium content of the pulp (93.58 %), number of female flowers (93.49 %), inter nodal length (93.27 %), number of leaves vine^{-1} at 30 DAS (92.97 %), rind thickness (92.27 %), number of fruits per vine (89.96 %), fruit set (88.13 %), days to first female flower (86.25 %), number of node of appearance of first male flower (85.68 %), calcium content of the pulp (83.65 %), node to first fruit initiation (81.48 %), days to first male flower (80.90 %), TSS (79.38 %), sex ratio (78.59 %), number of node of appearance of first female flower (76.97 %), ascorbic acid content of the pulp (64.32 %). High heritability indicates that the phenotype of the trait strongly reflects the genotype and suggests the major role of the genotypic constitution in the expression of the trait. Therefore, reliable selection could be made for these traits on the basis of phenotypic expression. This is in agreement with the findings of Ram *et al*. (2007), Husna (2009), Pandit (2009), Sharma and Sengupta (2013), Deepthi *et al*. (2016), Chouwan (2017), Rani and Reddy (2017), Singh *et al.* (2017), Kunjam (2018), Panigrahi and Duhan (2018), Rana *et al.* (2018), Kunjan (2018) and Rambabu (2017).

High heritability combined with high genetic advance as per cent of mean was observed for traits like plant height, inter nodal length, number of node of appearance of first male flower, days to first female flower, number of node of appearance of first female flower, number male flower, number of female flowers, node to first fruit initiation, sex ratio, fruit set per cent, days to first harvest, fruit length, fruit diameter, rind thickness, fruit weight, yield per plant, yield per plot, flesh thickness, TSS, ascorbic acid content of the pulp, dry matter content, calcium content of the pulp. The result showed that these traits were controlled by additive gene effects and phenotypic selection for these traits is likely to be effective. Similar kind of results were reported by Ram *et al.* (2006), Husna (2009), Pandit (2009), Sharma and Sengupta (2013), Deepthi *et al*. (2016), Chouwan (2017), Rani and Reddy (2017), Singh *et al.* (2017), Kunjam (2018), Panigrahi and Duhan (2018), Rana *et al.* (2018), Kunjan (2018) and Rambabu (2017).

5.4 CORRELATION STUDIES

Correlation coefficient analysis measures the mutual relationship between plant characters which determines the component character on which selection can be made for genetic improvement of yield. The knowledge of genetic association between yield and its component characters help in improving the efficiency of selection for yield by making proper choice and balancing one component with another. The magnitude of genotypic correlation was higher than the phenotypic correlation for all the traits indicated inherent association between various characters (Raut *et al*., 2013).

In the present study, observation clearly specified that genotypic correlations were of higher magnitude to the corresponding phenotypic ones, thereby establishing strong inherent relationship among the trait studied. The low phenotypic value might be due to the appreciable interaction of the genotypes with the environments (Dey *et al*., 2005; Said and Fatiha, 2015). Complete observation of the correlation coefficient analysis revealed that number of fruits per vine, fruit weight, number of branches vine^{-1}, number of male flowers, plant height, number of female flowers, duration of crop, fruit length, days to first harvest, number of node of appearance of first male flower and days to first male flower of crop revealed a significant positive correlation with fruit yield plant^{-1}. Hence, direct selection for these traits may lead to the development of high yielding genotypes of bottle gourd. Similar kind of results was reported by Kumar and Wehner (2011) and Choudhary *et al.* (2012) in watermelon; Bhardwaj *et al.* (2013) and Janaranjani and Kanthaswamy (2015) in bottle gourd.

Plant height^{-1} was positively and significantly correlated with the number of branches vine^{-1} and duration of crop. The number of branches vine^{-1} was positively and significantly correlated with number of female flowers and number of fruits per vine. The number of leaves vine^{-1} 30 at DAS had a significant positive association with number of female flowers. Internodal length had positive and significant association with fruit diameter. These results are in accordance with Umamaheswarappa *et al.* (2004), Husna (2009), Husna *et al*. (2011), Varpe *et al.* (2014), Janaranjani and Kanthaswamy (2015) in bottle gourd crop.

Days to first male flower was positively and significantly correlated with days to first female flower. Number of node of appearance of first male flower was positively and significantly correlated with number of node of appearance of first female flower. Days to first female flower was positively and significantly correlated with days to first harvest and duration of the crop, which indicates the presence of very strong association among these parameters regarding earliness. Number of node of appearance of first female flower negatively correlated with fruit set per cent. The number male flower was positively and significantly correlated with node to first fruit initiation and the number of fruits per vine. The number of female flowers was positively and significantly correlated with the number of fruits per vine and duration of the crop. The sex ratio was positively and significantly correlated with fruit set. The similar results was recorded by Umamaheswarappa *et al.* (2004), Wani *et al.* (2008), and Bhardwaj *et al.* (2013), Varpe *et al.* (2014) and Mahapatra (2017) in bottle gourd**.**

Fruit set per cent had a significant positive association with fruit weight. Days to first harvest was positively and significantly correlated with the duration of crop and yield plant^{-1}. Fruit length had highly significant and positive correlation with fruit weight, number of fruits per vine and yield plant^{-1}. Fruit diameter had a significant positive association with flesh thickness. Fruit weight had significant positive association with the fruit length, number of fruits per vine and yield plant^{-1} at both phenotypic and genotypic level indicating a strong association between average fruit weight, fruit length, number of fruits per vine. The duration of the crop had a significant positive association with yield plant^{-1}. These finding were also supported by Umamaheswarappa *et al.* (2004), Ram *et al.* (2007), Wani *et al.* (2008), Bhardwaj *et al.* (2013), Husna *et al*. (2011), Raut *et al.* (2013), Janaranjani and Kanthaswamy (2015) and Mahapatra (2017) in bottle gourd.

5.4.1 Path Coefficient Analysis

Correlation studies give an idea about the positive and negative associations of different traits with yield and also among themselves. However, the nature and extent of the contribution of these characters towards yield is not obtained. The total correlation between yield and its component characters may sometimes be misleading, as it might be a miscalculation or under-estimate of its association with other traits that are also associated with commercial crop yield. Path coefficient analysis can provide a more realistic picture of relationships between different traits, as it takes into consideration direct as well as indirect effects of the different yield components. Determination of interrelationships among yield components and between yield components and yield helps a plant breeder to easily identify traits that make the most important contribution to yield.

In this study, path coefficient analysis was used to find out the direct and indirect contribution of each traits on fruit yield. The plant height, number of branches vine^{-1}, number of leaves vine^{-1} 30 at DAS, inter nodal length, days to first male flower, number of node of appearance of first male flower, days to first female flower, number of node of appearance of first female flower, number male flower, number of female flowers, sex ratio, fruit set, node to first fruit initiation, days to first harvest, fruit length, fruit diameter, rind thickness, flesh thickness, fruit weight, number of fruits per vine**,** duration of crop into direct and indirect effects.

Among yield attributes, number of fruits per vine (1.2799) followed by days to first male flower (0.4853), fruit weight (0.4799), sex ratio (0.4405), days to first harvest (0.3435), flesh thickness (0.1689), rind thickness (0.1321), number of node of appearance of first female flower (0.1031), plant height (0.0228), number of female

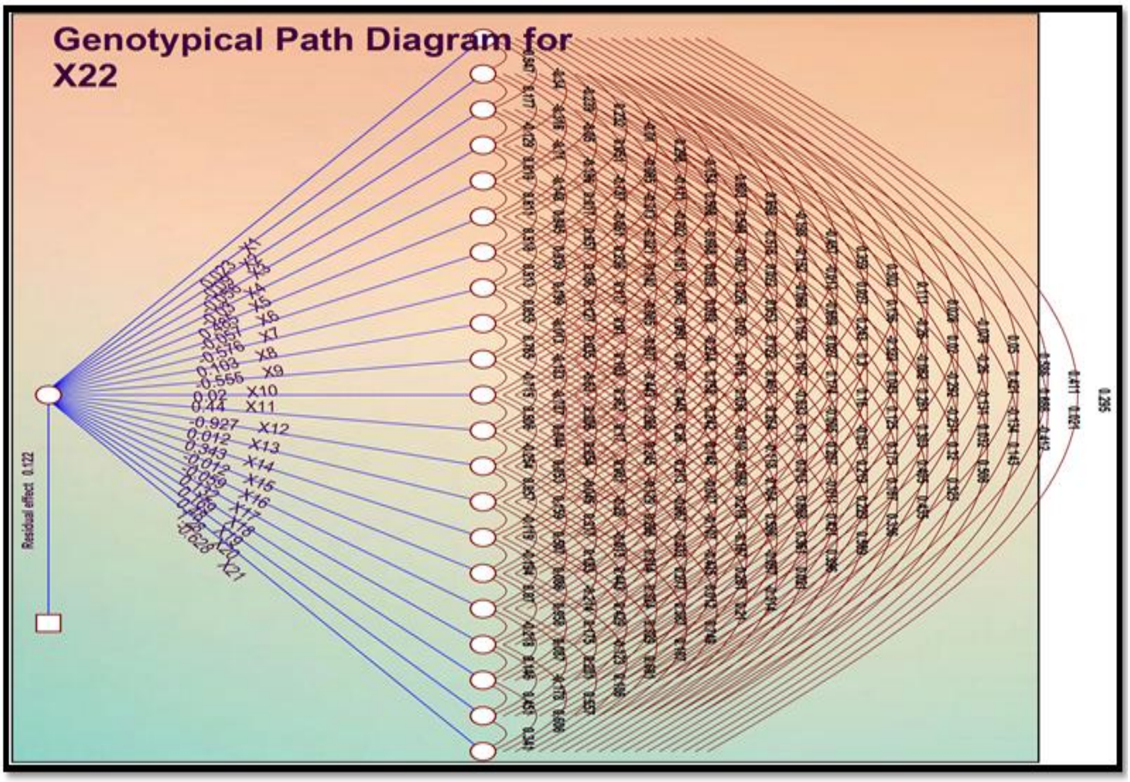


Fig. 7 Genotypic path diagram

flowers (0.0203), fruit set (0.0118). Number of fruits per vine and fruit weight also showed positive correlation with yield plant^{-1}. This indicated that direct selection based on number of fruits per vine and fruit weight would result in appreciable improvement of yield plant^{-1}. These findings are in agreement with studies of Kunjam (2018) in bottle gourd; Som (2018) in ridge gourd.

Number of node of appearance of first female flower, days to first male flower, days to first harvest, plant height, node to first fruit initiation, fruit weight also employed positive direct effect on yield plant^{-1} which is in accordance with Gayen and Hossain (2007), Janaranjani and Kanthaswamy (2015) and Mahapatra (2017) in bottle gourd.

Plant height showed a positive direct effect (0.0228) on yield. The trait also showed the maximum positive indirect effect through the number of male flowers (0.0183), number of female flowers (0.0159), fruit weight (0.0134). These findings are in agreement with studies of Mashilo *et al.* (2016), Yao *et al.* (2015) and Kunjam (2018) in bottle gourd.

Number of branches vine^{-1} showed the positive direct effect (-0.0899) on yield. This trait also showed high positive indirect effect through sex ratio (0.0337). These findings are in agreement with studies of Janaranjani and Kanthaswamy (2015) in bottle gourd.

Days to first male flower showed positively direct effect (0.4853) on yield. This trait, however, showed positive indirect effect through plant height (0.1128), days to first female flower (0.4588), first harvest (0.3506). These findings are in agreement with studies of Ram *et al.* (2007) and Kunjam (2018) in bottle gourd.

Number of node of appearance of first female flower showed a positive direct effect (0.1031) on yield. This trait also showed the highest positive indirect effect through number of node of appearance of first male flower (0.0968), days to first male flower (0.0677), days to first female flower (0.0529), days to first harvest (0.0459). These findings are in agreement with studies of Kunjam (2018) in bottle gourd.

Days to first harvest had a positive direct effect (0.3435) on yield. This trait also showed positive indirect effect through days to first female flower (0.2602), duration of crop (0.2571). These findings are in agreement with studies of Janaranjani and Kanthaswamy (2015), Thakur *et al.* (2017) and Kunjam (2018) in bottle gourd.

Number of fruits per vine showed a positive direct effect (1.2799) on yield. This trait also showed the highest positive indirect effect through number of branches vine^{-1} (0.88), fruit weight (0.5768). These findings are in agreement with studies of Thakur *et al.* (2017b) and Kunjam (2018) in bottle gourd.

It was found that fruit length showed the negative direct effect (-0.0122) on yield. The trait also showed the maximum positive indirect effect through flesh thickness (0.0026), fruit diameter (0.0024). These findings are in agreement with studies of Kumar *et al.* 2013, Husna *et al.* 2014, Thakur *et al.* (2017) and Sultana *et al.* (2018) in bottle gourd.

Fruit diameter showed a negative direct effect (-0.0585) on yield. This trait also showed the highest positive indirect effect fruit set (-0.0185) and node to first fruit initiation (0.0164). These findings are in agreement with studies of Kunjam (2018) in bottle gourd.

It was found that flesh thickness showed a positive direct effect (0.1689) on yield. The trait also showed the maximum positive indirect effect through fruit diameter (0.1619). These findings are in agreement with studies of Choudhary *et al.* (2003) and Janaranjani and Kanthaswamy (2015) in bottle gourd.

Number of fruits per vine showed a positive direct effect (1.2799) on yield. This trait also showed the highest positive indirect effect through number of branches vine^{-1} (0.88), fruit weight (0.5768). The result is in consonance with the finding of Mondal *et al.* (1989) in watermelon, Rabbani (2012) in ridge gourd, Rahman *et al*. (1986), Kumar *et al* (2007) and Singh *et al*. (2012) in bottle gourd.

It was found that the duration of crop showed the negative direct effect (-0.6283) on yield. The trait also showed the maximum positive indirect effect through number of leaves vine^{-1}at 30 DAS (0.2588), node to first fruit initiation (0.1972). The result is in agreement with studies of Thakur *et al.* (2017) in bottle gourd.

The path coefficient analysis revealed that number of fruits per vine and fruit weight had highest indirect positive effect on yield plant^{-1}. The indirect effects suggested that selection for any of these two traits would improve the yield through the associated traits.

Therefore, it can be inferred that number of fruits per vine and fruit weight were the main yield contributing traits in yield of bottle gourd because of its high, positive direct effect and positive correlation with fruit yield plant^{-1}. Since these traits also have a high level of heritability and high genetic advance, they can be considered dependable for improvement of yield in bottle gourd.

5.5 SELECTION INDEX

Selection of genotypes based on a suitable index is highly effective in any breeding program. Discriminant function analysis developed by Fisher (1936) gives material information on the proportionate weightage to be given to a yield component. Thus, the selection index was formulated to increase the efficiency of selection by taking into account the important characters contributing to yield. According to Hazel (1943), a selection index was more efficient than individual selection based on the individual trait.

Selection index was computed based on characters viz., plant height, days to first female flower, number of node of appearance of first female flower, number of female flowers, sex ratio, fruit set per cent, days to first harvest, rind thickness, flesh thickness, fruit weight, number of fruits per vine and yield plant^{-1}. Based on the selection index score, top-ranking genotypes were IC 536593 (2548.189), Tvpm Local (2474.530) and Pant Lauki-4 (2372.989) were found best ones. The identification of best genotypes based on discriminant function was done by Resmi (2004) in Ash gourd and Mashilo *et al*. (2017b) in bottle gourd crop.

SUMMARY

SUMMARY

The present investigation entitled "Evaluation of bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] genotypes for growth, yield and quality" was carried out at the Department of Vegetable Science, College of Agriculture, Kerala Agricultural University, Vellayani, during 2019-2020 with the objective to characterize and evaluate long type bottle gourd genotypes in order to identify potential cultivar for Kerala.

In the experiment, 31 long type bottle gourd genotypes were collected from public and private sectors and evaluated for high yield and quality. The evaluation was done in randomized block design (RBD) with two replications. The extent of variability, heritability and genetic advance of genotypes were assessed. The degree and direction of association between various traits and the direct and indirect effects of various components on yield were also analyzed. The salient findings of the investigation are summarized below.

Observations were recorded on different biometric characters *viz.*, plant height, number of branches vine-^{1}, number of leaves vine^{-1}at 30 DAS, inter nodal length, days to first male flower, number of node of appearance of first male flower, days to first female flower, number of node of appearance of first female flower, number of male flowers, number of female flowers, sex ratio, node to first fruit initiation, fruit set per cent, days to first harvest, fruit skin color, fruit shape, fruit length, fruit diameter, rind thickness, flesh thickness, fruit weight, number of fruits per vine, yield plant^{-1}, yield plot^{-1} and duration of crop. In addition to the quality characters *viz.*, TSS, ascorbic acid content of the pulp, dry matter content, crude fibre content, potassium (K) content of the pulp, calcium (Ca) content of the pulp and pest and disease observations were also noted.

The results pertaining to the analysis of variance for the experimental design indicated that the mean squares due to genotypes were significant for all the characters studied. Tvpm Local produced the longest vine length of 10.94 m which was at par with KS-1 (9.80 m) and IC284895 (9.36 m). Tvpm Local produced highest number of branches per vine of 9.2 followed by BG-8 (7.6), Naveen (6.6) and Samrat (6.4). Highest number of leaves per vine at 30 DAS was recorded in BG-6 (22.8). IC 538142 recorded longer inter-nodal length of 21.81 cm which was at par with BG-3 (21.12 cm).

The lowest node number to produce both male (6.1) and female (9.3) flower was observed in BG-6. BG-1 was early in male flower production (41.3 days) while, BG-2 was early in female flower production (44.3 days). Accession Tvpm Local produced highest number of male flowers (146.5) which was at par with BG-2 (141.8) and KAR-1 (137.6). Highest number of female flowers was noted in IC342077 (22.1) which were at par with Tvpm Local (19.8). Lowest sex ratio was recorded in IC342077 (5.96) which were at par with Tvpm Local (7.40).

The lowermost node to fruit initiation was recorded in BG-3 (13.7) which was at par with IC 284895 (15.0) and BG-13 (14.9). BG-3 was noted for highest fruit set (43.4%) followed by Arka Bahar (35.9%), IC 371745 (35.5%) and IC 334300 (35.1%). BG-2 was earliest to first fruit harvest with 57.8 days followed by Naveen (62.9 days), BG-3 (63.2 days). IC 371745 recorded longer fruit length of 68.8 cm which was at par with IC 538142 (62.2 cm). IC417704 recorded least fruit diameter and flesh thickness (15.97 cm and 12.56 cm) which was at par with IC146312 (13.38 cm and 10.95 cm). IC 331101 recorded lowest rind thickness (1.69 mm). Accession IC 536593 was recorded highest fruit weight (2410 g) and Pant Lauki-1 (2235.0 g), Pant Lauki-4 (2220.0 g) was at par with it. Tvpm Local recorded highest for six fruits per vine which was at par with Pant Lauki-4 (4.3) and Arka Bahar (4.2). Tvpm Local recorded highest fruit yield per plant and yield per plot (13.0 kg and 197.9 kg) with crop duration of 129.4 days. Highest crop duration of 137.2 days was observed in IC417704 and IC284891 (133.6 days) and IC 536593 (131.7 days) was on par with it.

The highest TSS and ascorbic acid content was noted in the BG-3 (2.5°B) and IC398545 (12.0 mg/100 g) respectively. BG-3 recorded highest dry matter content (6.71 %) which was at par with KAR-1 (5.93 %), IC 371745 (5.91 %) and Samrat (5.76 %). IC417704 produced least crude fiber, potassium (K) and calcium (Ca) content (27.2 g/100g, 3125 mg/100 g and 1600 mg/100 g) respectively.

Mild incidence red pumpkin beetle and cercospora leaf spot were noticed. High GCV and PCV were recorded for plant height, number of branches per vine, number of female flowers, fruit set (%), fruit length, flesh thickness, yield per plant, yield per plot, ascorbic acid content of the pulp and dry matter content. High estimates of heritability coupled with high to moderate genetic advance was recorded for all the yield components, indicating additive gene action.

Yield had positive and significant correlation both at genotypic and phenotypic level for the yield contributing traits such as plant height, number of branches per vine, days to first harvest, fruit length, fruit weight, number of fruits per vine and duration of crop respectively. Path coefficient analysis revealed that average yield per plant showed the highest positive direct effect on number of fruits per vine (1.2799) days to first male flower (0.4853), fruit weight (0.4799), sex ratio (0.4405), days to first harvest (0.3435), flesh thickness (0.1689), rind thickness (0.1321), number of node of appearance of first female flower (0.1031), plant height (0.0228), number of female flowers (0.0203) and fruit set (0.0118). The genotypes were ranked based on selection index score considering the major characters *viz.*, plant height, days to first female flower, number of node of appearance of first female flower, number of female flowers, sex ratio, fruit set per cent, days to first harvest, rind thickness, flesh thickness, fruit weight, number of fruits per vine and yield plant^{-1}. IC 536593 ranked first with a score of 2548.189 followed by Tvpm Local (2474.530), Pant Lauki-4 (2372.989) and Arka Bahar (1758.896).

Based on the mean yield performance of the genotypes and selection index score IC 536593, Tvpm Local and Pant lauki-4 were best performing accessions compared to others including Arka Bahar recommended variety for Kerala (KAU, 2016). So, those three accessions can be recommended for growing in Kerala condition after confirmation in extensive field trails.

FUTURE LINE OF WORK

The superior genotypes identified *viz.*, IC 536593, Tvpm Local and Pant Lauki-4 can be grown in the open field in a larger area for the confirmation of the results and if found superior, they can be recommended for commercial cultivation.

REFERENCES

REFERENCES

A.O. A. C, 1975. *Association of Official Agricultural Chemists Official Methods of Analysis* (12th Ed.). Benjamin Franklin station, Washington, D. C, 832p.

Abed, M. Y. 2018. Genetic improvement of yield and fruit traits in snake cucumber (*Cucumis melo var. flexuosus* L.) by individual selection. *Asian J. Biotechnol. Genet. Eng*. 1(2): 1-10.

Achigan-Dako, E. G., Fuchs, J., Ahanchede, A., and Blattner, F. R. 2008. Flow cytometric analysis in *Lagenaria siceraria* (Cucurbitaceae) indicates correlation of genome size with usage types and growing elevation. *Plant Syst. Evol.* 276: 9-19.

Ahsan, F. N., Islam, A. K. M. A., Rasul, M. G., Mian, M. A. K., and Hossain, M. M., 2014. Genetic variability in snake gourd (*Tricosanthes cucurminata*). *J. Agric. Technol*. 10(2): 355-366.

Alam, M. A., Rabbani, M. G., Rahaman, E. H. M. S., Kabir, M. R., and Mandal, M. S. N. 2006. Evaluation of some collected pointed gourd genotypes and their interrelationships. *Int. J. Bio. Res.* 4(1): 17-23.

Allard, R. W. 1960. Hybrid vigour and genetic control of some quantitative traits of tomato (*Solanum lycopersicum* L.). *Open J. genet.* 4(1): 485.

Anjula, P., Panwar, N. S., Singh, R., and Ahlawat, S. P. 2019. Vegetables: Status and priorities for exploration and germplasm collection in India. *ICAR- NBPGR New Delhi, India.* 97p.

Babu, R. and Rao, H. N. 2018. Studies on genetic variability, heritability and genetic advance in oriental pickling melon (*Cucumis melo* L. var. *conomon*) genotypes. *Int. J. Pure App. Biosci*. *6*(5): 1042-1047.

Bairwa, P. L. 2016. Genetic divergence analysis in indigenous germplasm of ash gourd [*Benincasa hispida* (Thunb.) Cogn.]. M. Sc. (Agri.) thesis, Indira Gandhi Krishi Vishwa Vidyalaya, Raipur. 97p.

Bello, M. O., Owoeye, G., Hammed, A. M., and Yekeen, T. A. 2014. Characterization of gourd fruits (Cucurbitaceae) for dietary values and anti-nutrient constituents. *Res. J. Pharm. Biol. Chem. Sci*. *5*(4): 232-226.

Bhardwaj, D. R., Singh, A., and Singh, U. 2013. Genetic variability of bottle gourd (Lagenaria siceraria (Mol.) Standl.) by multivariate analysis. In: Proceeding of national symposium on abiotic and biotic stress management in vegetable crops. *Indian Society of Vegetable Science*. 370p.

Bhowmik, S. and Saha, S. 2017. Study on the pest complex of bottle gourd in the gangetic plains of West Bengal. *J. of Entomol. and Zool. Stud*. 5(2): 725-727.

Burton, G. W. 1952. Variability, heritability and genetic advance in mulberry (*Morus spp*.) for growth and yield attributes. *Open J. genet.* 1: 277-283.

Buthelezi, L. G., Mavengahama, S., and Ntuli, N. R. 2019. Morphological variation and heritability studies of *Lagenaria siceraria* landraces from northern Kwazulu-Natal, South Africa. *J. Biol. Diversity* 20(3): 922-930.

Chandanshive, S. J. 2003. Studies on nutritional composition and shelf-life of some gourd Vegetables. M. Sc. (Agri.) thesis, Mahatma Phule Krishi Vidyapeeth, Rahuri. 96p.

Chaudhary, B. and Singh, B. 1981. Pusa Meghdoot and Pusa Manjari, two high yielding bottle gourd hybrids. *Indian Hortic*. 16(1): 15-17.

Choudhary, B. R, Dhaka, R. S., and Fageria, M. S. 2003. Association studies in musk melon correlation and path coefficient analysis in muskmelon. *Haryana J. Hortic. Sci*. 32: 98-101.

Choudhary, B. R., Kumar, S., and Sharma, S. K. 2014. Evaluation and correlation for growth, yield and quality traits of ridge gourd (*Luffa acutangula*) under arid conditions. *Indian J. Agric. Sci.* 84(4): 498-502.

Choudhary, B. R., Pandey, S., and Singh, P. K. 2012. Morphological diversity analysis among watermelon [*Citrullus lanatus* (Thunb.) Mansf.]. *Progressive Hortic.* 44(2): 321 326.

Chouwan, G. S. 2017. Study on genetic variability, heritability and correlation in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]. M. Sc. (Hort.) thesis, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, *Madhya Pradesh.* 119p.

Chulet, R., Joseph, L., George, M., and Pradhan, P. 2010. Pharmacognostic standardization and phytochemical screening of *Albizzia lebbeck*. *J. Chem. Pharm. Res*. 2(1): 432-443.

Ciba C. and Syamala, M. 2017. Study on flowering characters of bottle gourd (*Lagenaria siceraria*) by training and pinching. *Int. J. Curr. Microbiol. App. Sci.* 6(11): 3326-3328.

Damor, A. S., Patel, J. N., Parmar, H. K., and Vyas, N. D. 2016. Studies on genetic variability, heritability and genetic advances for yield and quality traits in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] genotypes. *Int. J. Sci. Environ. Technol.* 5(4): 2301 – 2307.

Deepthi, B., Reddy, P. S. S., Kumar, A. S., and Reddy, A. R. 2016. Studies on GCV, PCV, heritability and genetic advance in bottle gourd genotypes for yield and yield components. *Plant Arch*. 16(2): 597-601.

Deore, S. L., Khadabadi, S. S., and Patel, Q. R. 2009. *In vitro* antioxidant activity and quantitative estimation of phenolic content of *Lagenaria siceraria*. *Rasayan J. Chem.* 2(1):129-132.

Dewey, D. R. and Lu, K. H. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron. J.* 51: 515-518.

Dey, S. S., Behera, T. K., Pal, A., and Munshi, A. D. 2005. Correlation and path coefficient analysis in bitter gourd (*Momordica charantia* L.). *Veg. Sci*. 32: 173-176.

Dubey, S. K. and Maurya, I. B. 2007. Combining ability for characters related to yield and earliness in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]. *Indian J. Agric. Res*. 41(1): 59-62.

Erdinc, C., Turkmen, O., and Sensoy, S. 2008. Comparison of some local melon genotypes selected from lake-van basin with some commercial melon cultivars for some yield and quality related traits observed in field and high tunnel conditions. *African. J. Biotechnol.* 7(22): 4105-4110.

Fisher, R. H. 1936. The use of multiple measurements in taxonomic problems. *Ann. Eugenics* 7: 179-188.

Gaikwad, S. D. 2016. Genetic studies of F6 progenies in muskmelon (*Cucumis melo* L.) *Int. J. Agric. Sci.* 8(53): 2696-2698.

Gajera, R. R. 2017. Effect on juice quality of medicinal fruit bottle gourd during storage. *J. Med. Plants*. *5*(4): 56-60.

Ganiger, V. M., Bhuvaneshwari, G., Pallavi, H. M., and Madalageri, M. B. 2014. Performance studies of oriental pickling melon (*Cucumis melo var. Conomon*) genotypes under northern dry zone of Karnataka. *J. Environ. Ecol*. 7: 23-28

Gayen, N. and Hossian, M. 2007. Study of heritability and genetic advance in bottle gourd (*Lagenaria siceraria* (Molina) Standl.) *J. Interacademicia,* 10(4): 463-466.

Ghule, B. V., Ghanti, M. H., Yeole, P. G., and Saoji, A. N. 2007. Diuretic activity of *Lagenaria siceraria* fruit extracts in rats. *Indian J. Pharma. Sci*. 69: 817-819.

Gichimu, B. M., Owuor, B. O., and Dida, M. M. 2008. Agronomic performance of three most popular commercial watermelon cultivars in Kenya as compared to one newly introduced cultivar and one local landrace grown on dystric nitisols under sub- humid tropical conditions. *ARPN. J. Agri. Biol. Sci*. 3: 5-6.

Gurcan, K., Say, A., and Yesitir, H. 2015. A study of genetic diversity in bottle gourd [*Lagenaria siceraria* (Molina) Standl.] population, and implication for the historical origins on bottle gourds in Turkey. *Genet. Resour. Crop Evol*. 62: 321-333.

Hamid, A., Baloch, J. U. D. and Khan, N. 2002. Performance of six cucumber (*Cucumis sativus* L.) genotypes in Swat–Pakistan. *Int. J. of Agric. and Biol.* 4 (4): 491–492.

Haque, M. M., Hasanuzzaman, M., and Rahman, M. L. 2009. Effect of light intensity on the morpho-physiology and yield of bottle gourd (*Lagenaria vulgaris*). *Academic J. Plant Sci.* 2(3): 158-161.

Harika, M., Gasti, V. D., Shantappa, T., Mulge, R., Shirol, A. M., Mastiholi, A. B., and Kulkarni, M. S. 2012. Evaluation of bottle gourd genotypes [*Lagenaria siceraria* (Mol.) Standl.] for various Horticultural characters. *Karnataka J. Agric. Sci*. 25(2): 241-244.

Hazel, L. N. 1943. The genetic basis for constructing selection index. *Genet.* 28: 476-490.

Heiser, B. C. 1979. *The gourd book*. University of Oklahoma Press, Norman and London. 248p

Hidayatullah, T. M., Farooq, M., Khokhar, M. A., and Hussain, S. I. 2012. Plant growth regulators affecting sex expression of bottle gourd (*Lagenaria siceraria*) plants. *Pakistan J. Agric. Res.* 25(1): 51-54.

Husna, A. 2009. Genetic diversity, correlation and path co-efficient analysis in bottle gourd *(Lagenaria siceraria L.)* M. Sc. (Agri.) thesis Sher-E-Bangla Agricultural University, Dhaka, Bangladesh, 94p.

Husna, A., Mahmud, F., Islam, M. R., Mahmud, M. A. A., and Ratna, M. 2011. Genetic variability, correlation and path co-efficient analysis in bottle gourd (*Lagenaria siceraria* L.). *Advances Biological Res. 5*(6): 323-327.

Ilyas, M., Nabi, G., Ali, S., Anjum, M. M., Ali, N., Zaman, W., Jan, S., Samar, I. U., Sadiq, M., and Akber, S. 2017. Evaluation of bottle guard varieties in agro climatic condition of Peshawar valley. *Int. J. Environ. Sci. Nat. Res*. 3(1): 14-17.

Iqbal, M., Usman, K., Arif, M., Jatoi, S. A., Munir, M., and Khan, I. 2019. Evaluation of bottle gourd genotypes for yield and quality traits. *Sarhad J. Agric. 35*(1): 27-35.

Jackson, M. L. 1973. *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi, 498p.

Janaranjani, K. G. and Kanthaswamy, V. 2015. Correlation Studies and path analysis in bottle gourd. *J. Hortic*. 2(1):1-4.

Jeffrey, C. 1976. Cucurbitaceae. *Flora trop. E. Afr*. 1: 157p.

Johnson, H. W., Robinson, H. F., and Comstock, R. E. 1955. Estimates of genetic and environmental variability in soya beans. *Agron. J.* 47: 314-318

Joshi, B. K., Tiwari, R. K., Kc, H., Regmi, H. N., Adhikari, B. H., Ghale, M., Chaudhary, B., Gyawali, S., Upadhaya, M. P. and Sthapit, B. R. 2005. *Evaluation of sponge gourd* (*Luffa cylindrica* L.) *diversity for vegetable production.* In: Proceedings of 2nd national workshop on on-farm management of agricultural biodiversity in Nepal. Assessing the amount and distribution of genetic diversity on farm, Nagarkot, Nepal, pp. 122-131.

Kabir, M., 2010. Effect of reduced light intensities on growth and yield of two cucurbits. M. Sc. (Agri.) thesis, Sher-e-Bangla Agricultural University - Sher-e-Bangla Nagar, Dhaka. 62p.

Kalyanrao, P., Tomar, B. S., and Balraj, S. 2012. Influence of vertical trailing on seed yield and quality during seed production of bottle gourd (*Legenaria siceraria*) cv. Pusa Hybrid-3. *Seed Res.* 40(2): 139–44.

Kalyanrao, P., Tomar, B. S., Singh, B., and Aher, B. 2016. Morphological characterization of parental lines and cultivated genotypes of bottle gourd (*Lagenaria siceraria*). *Indian J. Agric. Sci.* 86(1): 65-70.

Kamal, N., Verma, S., Agrawal, S., and Rao, S., 2012. Genetic variability and correlation studies in bottle gourd grown as intercrop in coconut garden. *Plant Arch.* 12(1): 85-88.

Kandasamy, R., Arivazhagan, E., and Bharathi, S. S. 2019. Evaluation of growth and yield characters in bottle gourd (*Lagenaria siceraria* (Mol.) Standl.). *J. Pharmacognosy Phytochemistry* 8(3): 4653-4655.

Karthik, D., Varalakshmi, B., Kumar, G., and Lakshmipathi, N. 2017. Genetic variability studies of ridge gourd advanced inbred lines (*Luffa acutangula* (L.) Roxb.). *Int. J. Pure Appl. Biosci. 5*(6): 1223-1228.

Kerala Agricultural University. 2016. Package of Practices Recommendations: Crops (15th Ed.) Kerala Agricultural University, Thrissur, 392 p.

Koppad, S. B., Chavan, M. L., Hallur, R. H., Rathod, V., and Shantappa, T. 2015. Variability and character association studies in ridge gourd (*Luffa acutangula* Roxb.) with reference to yield attributes. *J. Glob. Biosci.* 4(5): 2332-2342.

Kubde, M. S., Khadabadi, S. S., Farooqui, I. A., and Deore, S. L. 2010. *Lagenaria siceraria*: Phytochemistry, pharmacognosy and pharmacological studies. *Rep. Opinion.* 2(3): 14-21.

Kumar, M. and Kumar, K. 2018. Economic analysis of hybrid and conventional varieties of bottle gourd as affected by different levels of nitrogen and plant spacing. *Int. J. Curr. Microbiol. Appl. Sci*. 7(8): 2632-2638.

Kumar, R. and Prasad, V. M. 2011. Hybrid evaluation trial in bottle gourd gourd [*Lagenaria siceraria* (Mol.) Standl.]. *Environm. Eco*. 29(1): 7477.

Kumar, R. and Wehner, T. C. 2011. Inheritance of fruit yield in two watermelon populations in North Carolina. *Euphytica*. 182: 275-283.

Kumar, R., Ameta, K. D., Dubey, R. B., and Pareek, S. 2013. Genetic variability, correlation and path analysis in sponge gourd (*Luffa cylindrica* Roem.). *African J. Biotechnol.* 12(6): 539-543.

Kumar, S. 2018. Evaluation of genotypes for quantitative traits in bottle gourd (*Lagenaria siceraria* (Mol.) standl.). *J. Pharmacognosy Phytochemistry* 7(3): 841-843.

Kumar, S., Singh, R., and Pal, A. K., 2007. Genetic variability, heritability, genetic advance, correlation coefficient and path analysis in bottle gourd. *Indian J. Hortic.* 64(2):163-168.

Kunjam, K., 2018. *Evaluation of bottle gourd [Lagenaria siceraria (Mol.) Standl.] genotypes in Chhattisgarh plain*. M. Sc. (Agri.) thesis, Indira Gandhi Krishi Vishwavidyalaya, Raipur. 71p.

Kunjam, K., Sharma, P. K., Som, I., and Kumar, B. 2019. Correlation studies and path analysis in bottle gourd [*Lagenaria siceraria* (Molina) Standl.]. *J. Pharmacol. Phytochemistry*. 8(1):1554-1556.

Lee, J. M., 1994. Cultivation of grafted vegetables I. Current status: grafting methods and benefits. *Hortic. Sci.* 29: 235-239.

Mahapatra, S. 2017. Genetic diversity study in bottle gourd *[Lagenaria siceraria* (Mol.) Standl.] using morphological and molecular markers. M. Sc. (Vegetable Science) thesis, Division of Vegetable Science ICAR-Indian Agricultural Research Institute New Delhi. 81p.

Mahato, B., Pandit, M. K., and Sarkar, A. 2010. Evaluation of some indigenous bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] genotypes in the new alluvial zone of West Bengal. *J. Interacademicia* 14(4): 440-443.

Mandal, J., Tirumalesh, M., and Dhangrah, V. K. 2015. Studies on genetic variability and trait inter- relationship in bottle gourd [*Lagenaria siceraria* (Mol.) Standl]. *Hortic. Flora Res. Spect.* 4: 34-38.

Manu, K. K. 2014. Genetic variability and divergence studies in oriental pickling melon (*Cucumis melo var. conomon*). M. Sc. thesis, University of Horticultural Scinces, Bagalkot, 92p.

Mashilo, J., Shimelis, H. A., Odindo, A., and Amelework, B. A. 2017a. Genetic differentiation of bottle gourd [*Lagenaria siceraria* (Molina) Standl.] landraces assessed by fruit qualitative traits and simple sequence repeat markers. *Sci. Hortic*. *216*: 1-11.

Mashilo, J., Shimelis, H. and Odindo, A. 2017b. Yield-based selection indices for drought tolerance evaluation in selected bottle gourd [*Lagenaria siceraria* (Molina) Standl.] landraces. *Acta. Agri. Scandinavica*. 67(1): 43-50.

Mashilo, J., Shimelis, H., and Odindo, A. 2016. Correlation and path coefficient analyses of qualitative and quantitative traits in selected bottle gourd landraces. *Acta. Agric. Scandinavica.* 66(7): 558-569.

Mathew, A., Baby., Lissy, M., Rajan, S., and Peter, K. V. 2000. Genetic variability in bottle gourd [*Lagenaria siceraria* (Molina) Standl.]. *Cucurbit Genet. Cooperative Rep*. 23: 78-79.

Mondal, S. N., Rashid, A., Inouve, K., Hossain, A. K. M. A., and Hossain, M. A. 1989. Genetic variability, correlation and path co-efficient analysis in watermelon. *Bangladesh. J. Plant Breed*. *Genet*. 2(1): 31-35.

Morimoto, Y., Maundu, P., Fujimaki, H., and Morishima, H. 2005. Diversity of landraces of the white flowered gourd (*Lagenaria siceraria*) and its wild relatives in Kenya fruit and seed morphology. *Gen. Resour. Crop Evol*. 52: 737-747.

Narayan, R., Singh, S. P., Sharma, D. K., and Rastogi, K. B. 1996. Genetic variability and selection parameters in bottle gourd. *Indian J. Hortic*. 53(1): 53-58.

NHB (National Horticulture Board) 2018. Area of Bottle gourd (ha) and production quantity (tonnes) in 2017-18. In: Final Estimate of Area and Production of Horticulture Crops. Available: http://nhb.gov.in/statistics/State_Level/2017-18-(Final).pdf

Nicola, C., Donato, D. I., and Vito, L. 1999. Technological and quantitative aspects of calabash gourd (*Lagenaria siceraria*) for processing. *Acta Hortic.* 492: 179-186.

Nisha, S. K. 2017. Standardization of agrotechniques for precision farming in watermelon [*Citrultus lanatus* (Thunb.) Mastum. & Nakai]. Ph.D. thesis, Kerala Agricultural University, Thrissur, 210p.

Pandit, M. K., Mahato, B., and Sarkar, A. 2009. Genetic variability, heritability and genetic advance for some fruit characters and yield in bottle gourd (*Lagenaria siceraria*). *Acta Hortic*. 809: 221-225.

Pandiyan, R., Pugalenthi, L., and Sathyamurthy, V. A. 2019. Evaluation of vegetative growth and yield performance of bottle gourds (*Lagenaria siceraria* L.). *Int. J. Genet.* 11(5): 594-596.

Panigrahi, I. and Duhan, D. S. 2018. Study of variability and morphological characterization of cultivated genotypes of bottle gourd [*Lagenaria siceraria* (Mol.) Stdl.]. *Int J. Chem. Stud*. 6(1): 1863-1866.

Panse, V. G. and Sukhatme, P. V. 1985. Statistical *Methods for Agricultural Workers* (4th Ed.). Indian Council of Agricultural Research, New Delhi, 347p.

Parle, M. and Kaur, S. 2011. Is bottle gourd a natural guard. *Int. Res. J. Pharmacy* 2(6): 13-17.

Patle, B. J., Wagh, A. P., Umbarkar, P. S., and Bondre, S. V. 2018. Integrated nutrient management studies in bottle gourd. *J. Pharmacol. Phytochemistry*. *7*(5): 1383-1385.

Phan, T. T., Truong, H. T. H., Nguyen, S. C. H., Nguyen, T. T. T., and Tran, T. V. 2015. Evaluation of promising sponge gourd (*Luffa cylindrical*) accessions in summer-autumn season in Thua Thien Hue. *J. Agric. Sci. Technol.* 5: 508-514.

Piper, C. S. 1966. *Soil and Plant Analysis*. University of Adelaide, Australia, 368 p.

Prasad, V. S., Pitchaimuthu, R. K., and Dutta, O. P. 2004. Variation, diversity pattern and choice of parental selection in muskmelon (*Cucumis melo* L.) improvement. *Indian J. Hortic.* 61(4): 319-322.

Rabbani, M. G., Naher, M. J., and Hoque, S. 2012. Variability, character association and diversity analysis of ridge gourd (*Luffa acutangula* Roxb.) genotypes of Bangladesh. *SAARC. J. Agric.* 10(2): 1-10.

Rahman, A. K. M. M., Das, M. K., and Haque, M. M. 1986. Variability correlation and path coefficient analysis in bottle gourd [*Lagenaria siceraria* (Molina) Standl.]. *Bangladesh J. Agric.* 11(3): 13-20.

Ram, D., Rai, M., and Yadav, D. S. 2007. Characterization and evaluation of winter fruited bottle gourd (*Lageneria sicereria* (Mol.) Stand). *Acta Hortic*. 752: 231-237.

Rambabu, E., Mandal, A. R., Hazra, P., Senapati, B. K., and Thapa, U. 2017. Morphological characterization and genetic variability Studies in bottle gourd

[*Lagenaria siceraria* (Mol.) Standl.]. *Int. J. Curr. Microbiol. App. Sci.* 6(9): 3585-3592.

Rana, H., Pant, S. C., Paliwal, A., Bahuguna, P., and Veena, A. M. 2018. Studies on genetic variability among various Horticicultural traits of bottle gourd. *Int. J. Pure App. Biosci.* 6(6): 1014-1018.

Rani, K. U. and Reddy, E. N. 2017. Variability and correlation studies in bottle gourd. *Int. J. Pure Appl. Biosci.* 5(2): 723-731.

Rao, B. N., Rao, P. V., and Reddy, B. M. M. 2000. Correlation and path analysis in the segregating population of ridge gourd (*Luffa acutangula* (Roxb.) L.). *Crop Res.* 20(2): 338-342.

Rathore, J. S., Collis, J. P., Singh, G., Rajawat, K. S., and Jat, B. L. 2017. Studies on genetic variability in ridge gourd [*Luffa acutangula* L. (Roxb.)] genotypes in Allahabad agro-climate condition. *Int. J. Curr. Microbiol. App. Sci.* 6(2): 317-338.

Raut, R. L., Mishra, S. P., Verma, A., and Jain, P. K. 2013. Correlation studies in bottle gourd. *JNKVV. Res. J.* 47(1): 76-79

Reddy, R. P., Reddy, V. S. K., and Padma, S. S. V. 2013. Performance of parents and hybrids for yield and yield attributing characters in ridge gourd (*Luffa acutangula* (Roxb.) L.). *The Bioscan* 8(4): 1373-1377.

Resmi, J. 2004. Characterization of landraces of ash gourd (*Benincasa hispida* (Tunb.) Cogn.). M.Sc. (Agri.) thesis, Kerala Agricultural University, Thrissur, 158p.

Resmi, J. and Sreelathakumary, I. 2015. Genetic variability of bitter gourd (*Momordica charantia* L.) genotypes in India. *Acta Sci. Int. J. Agric.* 1(1): 36-40.

Sadasivam, S. and Manickam, A. 1992. Phenolics. *Biochemical methods for agricultural Sciences.* 187-188pp.

Sahu, B., Sarvanan, S., Rangare, S. B., Sinha, S., and Sao, P. 2014. Varietal evaluation of bottle gourd under Allahabad agro climatic condition [*Lagenaria siceraria* (Mol.) Standl.]. *Trends Biosci.* 7(2): 88-89.

Sahu, L. 2016. Genetic diversity, heritability and agro-morphological characterization in bottle gourd [*Lagenaria siceraria* (Molina) Standl.]. M. Sc. (Hort.) thesis, IGKV, Raipur, Chhattisgarh, 78p.

Sahu, P. K., Sharma, D., and Nair, S. K. 2015. Performance of ash gourd genotypes for earliness and yield under Chhattisgarh Plains, India. *Plant Arch*. 15(2): 1157-1160.

Said, E. M. and Fatiha, H. 2015. Genotypic variation in fruit characters in some genotypes of watermelon cultivated in Morocco. *Int. J. Agric. Res.* 6(4): 130-137.

Salunkhe, D. K. and Kadam, S. S. 1998. *Handbook of Vegetable Science and technology*: Production, Composition, Storage and Processing. Marcel Dekker Inc, New York, 279p.

Samadia, D. K. 2002. Performance of bottle gourd genotypes under hot arid environment. *Indian J. Hortic*. 59(2): 167-170.

Samadia, D. K. 2007. Studies on genetic variability and scope of improvement in round melon under hot arid conditions. *Indian J. Hortic*. 64(1): 58-62.

Sharma, A. and Sengupta, S. K. 2013. Genetic diversity, heritability and morphological characterization in bottle gourd (*Lagenaria siceraria* (mol.) stand). *The Bioscan* 8(4): 1461-1465.

Sharma, B. R., Singh, J., Singh, S., and Singh, D. 1997. Genetical studies in bottle gourd. *Veg. Sci*. 29: 102-111.

Sharma, M., Singh, Y., and Suryavanshi, P. 2019. Assessment of Bottle Gourd (*Lagenaria siceraria*) varieties for fruit yield and component traits in Mohali district of Punjab. *J. Krishi Vigyan* 8(1): 5-7.

Sharma, R. K., Tomar, B. S., Singh. S. P., and Kumar, A. 2016. Influence of growing direction on seed yield and quality in bottle gourd [*Lagenaria siceraria*]. *Indian J. Agric. Sci.* 86 (7): 895-900.

Shinde, R. D., Vadodaria, J. R., Savale, S. V., and Vasava, H. V. 2014. Effect of nature of cultivation and different varieties on flowering, yield attributes and yield of bottle gourd (*Lagenaria siceraria* Mol. Standl.). *Trends Biosci. 7*(24): 4340-4345.

Singh, A. K., Pan, R. S., and Bhavana, P. 2012. Correlation and path coefficient analysis for quantitative traits in early season bottle gourd (*Lagenaria siceraria* (Mol.) stand L.). *Veg. Sci. 39*(2): 198-200.

Singh, B. and Singh, S. K. 2014. Evaluation trial of bottle gourd. *Asian J. Hortic*. *9*(1): 116-119.

Singh, D. K. and Kumar, R. 2002. Studies on the genetic variability in bottle gourd [*Lagenaria siceraria* (Molina) Standl.]. *Progressive Hortic.* 34(1): 99-101.

Singh, H. K., Kumar, R., Akhtar, S., and Adarsh, A. 2017. Seasonal variation and genotypic variability studies on bottle gourd for yield and it's attributing traits. *Int. J. Agric. Environ. Biotechnol.* 10(3): 357-366.

Singh, K. P., Choudhury, D. N., Mandal, G., and Saha, B. C. 2008. Genetic variability in bottle gourd [*Lagenaria siceraria* (Molina) Standl.]. *J. Interacademician* 12(2): 159-163.

Singh, S. K., Singh, B., Kumar, U., and Rai, M. 2013. Heterosis analysis in bitter gourd through line × tester design. *Veg. Sci.* 34: 95.

Sithole, N. J., Modi, A. T., and Pillay, K. 2015. An assessment of minerals and protein contents in selected South African bottle gourd landraces [*Lageraria siceraria* (Mol. Standl.)]. *J. Hum. Ecol*. 51(3): 279-286.

Sivaraj, N. and Pandravada, S. R. 2005. Morphological diversity for fruit characters in bottle gourd germplasm from tribal pockets of Telangana region of Andhra Pradesh, India. *Asian Agric. Hist*. 9(4): 305-310.

Sivasubramanian, S. and Menon, M. 1973. Heterosis and inbreeding depression in rice. *Madras Agric. J*. 60: 1139.

Smith, F. H. 1937. A discriminate function for plant selection. *Ann. Eugen*. 7: 240- 250.

Som, I. 2018. Variability and character association studies in sponge gourd (*Luffa cylindrica* L. Roem.) for yield and its attributing traits. M.Sc. (Hort.) thesis, Indira Gandhi Krishi Vishwavidyalaya, Raipur, 114p.

Sultana, S., Rahman, M. S., Ferdous, J., Ahamed, F., and Chowdhury, A. K. 2018. Studies on genetic variability and interrelationship in bottle gourd [*Lagenaria siceraria* (Mol.) Standl]. *Int. J. Agricultural Res. Innovation Technol*. 8(1):14-17.

Sunil, N., Reddy, M. T., Hameedunnisa, B., Vinod, P., Rao, S., Sivaraj, N., Kamala, V., Prasad, R. B. N., Rao, B. V., and Chakrabarty, S. K. 2014. Diversity in bottle gourd (*Lagenaria siceraria* (Molina) Standl.) Germplasm from peninsular India. *Electr. J. Plant Breed* 5(2): 236-243.

Sureshkumara, B., Puttaraju, T. B., and Pavithra, H. B. 2017. Evaluation of bitter gourd (*Momordica charantia* L.) hybrids under eastern dry zone of Karnataka, India. *Int. J. Curr. Microbiol. App. Sci*. 6(11): 1931-1939.

Tadkal, R., Beaulah, A., Krishnamoorthy, V., and Thangaraj, K. 2019. Evaluation of ash gourd (*Benincasa hispida*) genotypes for growth and yield under pandal system of cultivation. *Int. J. Chem. Stud*. (3): 2933-2937.

Tamil, N. A., Jansirani, P., Pugalendhi, L., and Nirmalakumari A. 2012. Performance of genotypes and correlation analysis in Pumpkin (*Cucurbita moschata*). *Electr. J. Plant Breed* 3(4): 987- 994.

Thakur, P., Sharma, D., Dash, S. P., and Nair, S. K. 2015a. Genetic divergence in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]. *J. Environ. Biosci*. 29(2): 555-558.

Thakur, P., Sharma, D., Visen, V. K., and Dash, S. P. 2015b. Evaluation of bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] genotypes. *Plant Arch.* 15(2): 1037-1040.

Thakur, P., Singh, J., Nair, S. K., and Dash, S. P. 2017. Correlation and path analysis in bottle gourd [*Lagenaria siceraria* (Molina) Standl.]. *Int. J. Curr. Microbiol. Appl. Sci.* 6(12):1478-1485.

Tirumalesh, M. and Mandal, J. 2018. Evaluation of bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] genotypes during post-rainy season in red and laterite zone of West Bengal. *J. Crop Weed* 14(3):185-188.

Tirumalesh, M., Mandal, J., and Dhangrah, V. K. 2016. Variation in Flowering Characters of Bottle Gourd. *Hortic. Flora Res. Spect*. 5(1): 39-42.

Tomar, B. S., Singh, B., and Aher, B. M. 2015. Effect of pollination time on fruit set, seed yield and seed quality of bottle gourd cv. Pusa hybrid-3. *J. Life Sci.* 12(1): 90-94.

Tyagaraj, G. N., Puttaraju, T. B., Santosh. N., Padmaraja, S. R., and Prakash. 2014. Evaluation of F1 hybrids in oriental pickling melon for yield and quality attributes. *Trends Biosci*. 7(17): 2518-2523.

Uddin, A. F. M., Jamal., Tahiduls, M. I, Chowdhury, M. S. N., Shiama, I. H., and Mehraj, H. 2014. Evaluation of bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] to growth and yield. *Int. J. Biosci.* 5(12): 7-11.

Umamaheswarappa, P., Krishnappa, K. S., Murthy, P. V., Nagarajappa A., and Muthu, M. P. 2004. Correlation and path coefficient analysis studies in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] cv Arka Bahar. *Environ. Ecol.* 22 (4): 636-640.

Vaishali, V. 2016. Studies on genetic variability, divergence and character association in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] M. Sc. (Agri.) thesis, University of Agriculture and Technology Bhubaneshwar, Odisha, 86p.

Varpe, B. H., Acharya, R. R., Shaikh, J. A., and Christian, S. S. 2014. Interrelationship and contribution of yield components of fruit yield in bottle gourd [*Lagenaria siceraria* (Mol.) Standi.]. *Crop Res*. 48(1-3): 67-71.

Visen, V. K., Sharma, D., and Thakur, P. 2014. Genetic variability in bottle gourd [*Lagenaria siceraria* (Molina) Standl.]. *Environ. Ecol*. 34(4): 2466-2471.

Vittal, R. K. 2016. Evaluation of different genotypes of bottle gourd in karyomere plateau and satpura hill of MP. M. Sc. (Horti.) Jawaharlal Nehru Krishi Vishwa Vidyalaya Jabalpur, Madhya Pradesh, 51p.

Wang, H. X. and Ng, T. B. 2000. Lagenin, a novel ribosome-inactivating protein with ribonucleolytic activity from bottle gourd (*Lagenaria siceraria*) seeds. *Life Sci.* 67(21): 2631-2638.

Wani, K. P., Ahmed, N., and Hussain, K. 2008. Gene action studies in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]. *Indian J. Agric. Sci*. 78(3): 258-260.

Xu, P., Xu, S., Wu, X., Tao, Y., Wang, B., Wang, S., Qin, D., Lu, Z., and Li, G. 2014. Population genomic analyses from low-coverage RAD-Seq data: a case study on the non-model cucurbit bottle gourd. *Plant J.* 77: 430–442.

Yadav, Y. C. and Kumar, S. 2012. Studies on genetic variability, correlation coefficient and path analysis in bottle gourd [*Lagenaria siceraria* (Mol) Standl.]. *Ann. Hortic.* 5(1): 80-89.

Yao, K. A. G, Koffi, K. Ondo-Azi, S. A., Baodoin, J. P., Zoro., and Bi, I. A. 2015. Identification and analysis for exploiting recombinative heterosis in bottle gourd. *Int. J. Veg. Sci.* 21: 441–453.

Yetisir, H. and Sari, N. 2003. Effect of different rootstock on plant growth, yield and quality of watermelon. *Australian J. Exp. Agric*. 43: 1269-1274.

Yetisir, H., Sakar, M., and Serce, S. 2008. Collection and morphological characterization of *Lagenaria siceraria* germplasm from the Mediterranean region of Turkey. *Genet. Resour. Crop Evol*. 55: 1257-1266.

ABSTRACT

ABSTRACT

The present investigation was conducted at the Department of Vegetable Science, College of Agriculture,Vellayani from September 2019 to Decembe 2020 to evaluate the performance of long type bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] genotypes for growth, yield and quality and to identify potential cultivar for Kerala.

The experimental material consisted of 31 long type bottle gourd genotypes. The experiment was laid out in RBD with two replications. Analysis of variance revealed that there was significant difference among the thirty-one genotypes for all the characters studied.

Tvpm Local produced the longest vine length which was at par with KS-1 and IC284895. Tvpm Local produced highest number of branches per vine followed by BG-8, Naveen and Samrat. Highest number of leaves per vine at 30 DAS was recorded in BG-6. IC 538142 recorded longer inter-nodal length which was at par with BG-3. The lowest node number to produce both male and female flower was observed in BG-6. BG-1 was early in male flower production while, BG-2 was early in female flower production. Accession Tvpm Local produced highest number of male flowers which was at par with BG-2 and KAR-1. Highest number of female flowers was noted in IC342077 which were at par with Tvpm Local. Lowest sex ratio was recorded in IC342077 which were at par with Tvpm Local.

The lowermost node to fruit initiation was recorded in BG-3 which was at par with IC 284895 and BG-13. BG-3 was noted for highest fruit set followed by Arka Bahar, IC 371745 and IC 334300. BG-2 was earliest to first fruit harvest followed by Naveen, BG-3. IC 371745 recorded highest fruit length which was at par with IC 538142. IC417704 recorded highest fruit diameter and flesh thickness which was at par with IC146312. IC 331101 recorded least rind thickness. Accession IC 536593 was recorded for highest fruit weight and Pant Lauki-1 was at par with it. KA-1 recorded highest of six fruits per vine which was at par with Pant Lauki-4.

Tvpm Local recorded highest fruit yield per plant and yield per plot (13.0 kg and 197.9 kg) with crop duration of 129.4 days. Maximum crop duration was observed in IC417704 and IC284891 and IC 536593 were on par with it. The Highest TSS and

ascorbic acid content was noted in the BG-3 and IC398545 respectively. BG-3 recorded highest dry matter content which was at par with KAR-1, IC 371745 and Samrat. IC417704 produced highest crude fiber, potassium and calcium content.

High GCV and PCV were recorded for plant height, number of branches per vine, number of female flowers, fruit set, fruit length, flesh thickness, yield per plant, yield per plot, ascorbic acid content of the pulp and dry matter content. Yield had positive and significant correlation both at genotypic and phenotypic level for the yield contributing traits such as plant height, number of branches per vine, days to first harvest, fruit length, fruit weight, number of fruits per vine and duration of crop respectively. Path coefficient analysis revealed that average yield per plant showed the highest positive direct effect on number of fruits per vine, days to first male flower, fruit weight, sex ratio, days to first harvest, flesh thickness, rind thickness, number of node of appearance of first female flower, plant height, number of female flowers and fruit set. The genotypes were ranked based on selection index score considering the major characters *viz*., plant height, days to first female flower, number of node of appearance of first female flower, number of female flowers, sex ratio, fruit set, days to first harvest, rind thickness, flesh thickness, fruit weight, number of fruits per vine and yield plant^{-1}. IC 536593 ranked first with a score of 2548.189 followed by Tvpm Local (2474.530), Pant Lauki-4 (2372.989) and Arka Bahar (1758.896).

Based on the mean yield performance of the genotypes and selection index score IC 536593, Tvpm Local and Pant lauki-4 were best performing accessions compared to others including Arka Bahar recommended variety for Kerala (KAU, 2016). So, those three accessions can be recommended for growing in Kerala condition after confirmation in extensive field trails.

APPENDICES

APPENDIX-I: Weekly Meteorological Data during crop growth period (from Sept. 2019 and Feb. 2020).

Number of weeks	Date	Temperature		Relative Humidity (%)		Sunshine hours	Rainy fall (days)
		Max.	Min.	Max.	Min.		
1	07-Oct.	31.5	24.6	91.3	72.1	5.7	1
2	14-Oct.	31.1	24.4	91.7	77	5.5	5
3	21-Oct.	30.9	24.2	94.9	80.3	3.1	6
4	28-Oct.	30.3	23.6	91.3	77.7	0.8	5
5	04-Nov.	28.8	24.0	95.0	78.7	4.7	4
6	11-nov.	32.5	24.8	89.3	68.1	9	0
7	18-Nov.	32.4	24.6	90.7	67.4	8.1	2
8	25-Nov.	32.0	24.3	92.4	74.4	5.6	4
9	2- Dec.	32.6	24.5	94.0	69.1	5.4	1
10	09-Dec.	31.9	24.1	91.3	69.6	1.8	7
11	16- Dec.	32.2	23.6	91.0	70.9	7.5	1
12	23- Dec.	31.3	23.9	92.9	72.4	5.9	1
13	31- Dec.	36.4	23.8	92.75	69	7.5	0
14	07- Jan.	32.2	24.1	92.3	66.1	8.8	0
15	14-Jan.	32.0	22.7	93.4	66.3	7.8	1
16	21-Jan.	32.2	22.5	92.3	63.7	8.3	1
17	28-Jan.	32.7	23.0	91.4	64.1	9.6.0	0
18	04-Feb.	32.7	22.3	92.7	57.9	9.4	0
19	11-Feb.	32.7	23.2	91.4	63.3	9.1	0