Studies on genetic variability, character association and physiological analysis in sponge gourd

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By

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2016

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*This is to certify that the thesis entitled "***Studies on genetic variability, character association and physiological analysis in sponge gourd"** *submitted in partial fulfilment of the requirement for the degree of* ***MASTER OF SCIENCE in Agriculture, Horticulture (Vegetable Science)*** *of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur is a record of the bonafide research work carried out by* ***Mr. Nilesh Sharma*** *under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instructions.*

All the assistance and help received during the course of the investigation have been acknowledged by him.

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Place: Jabalpur **(Nilesh Sharma)**

Date:

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LIST OF SYMBOLS

Abbreviation	Stand for
@	At the rate
&	And
ANOVA	Analysis of Variance
Cm	Centimeter
C.D.	Critical difference
d.f.	Degrees of Freedom
DAH	Days after harvesting
et al.	Et al (And others or co-workers)
M	Meter
Fig.	Figure
GA	Genetic Advance
GCV	Genotypic coefficient of variation
G	Gram
Ha	Hectare
Kg	Kilogram
Max.	Maximum
Min.	Minimum
M.S.S.	Mean Sum of Squares
MT	Metric ton
No.	Number
PCV	Phenotypic coefficient of variation
SEm±	Standard error mean
YVMV	Yellow Vein Mosaic Virus
%	Percentage

INTRODUCTION

Vegetable are an indispensable part of human diet. The present and future need for the country requires considerable augmentation in production. Hence, there is a need to formulate cropping strategy as the vegetables have a great potential to contribute directly to the income, employment and nutrition of majority of rural as well as urban population of our country.

Cucurbits share about 5. 6% of the total vegetable production of India and according to FAO estimate, cucurbits were cultivated on about 4,290,000 ha with the productivity of 10.52 t/ha. According to an estimate, India will need to produce 215,000 tonnes of vegetables to provide food and nutritional security at individual level and being a large group of vegetables; cucurbits provide better scope to enhance overall productivity and production.

Cucurbits form an important and big group of vegetable crops and sponge gourd (*Luffa cylindrica* Roem Syn. *Luffa aegyptiaca*) is one of the important members of this group. Sponge gourd has been cultivated for centuries in the Middle East and India, China, Japan and Malaysia. Sponge gourd is native to Tropical Asia, probably India and South East Asia. The tender fruit is used as vegetable which is easily digestible and increase appetite when consumed. Besides being a vegetable, the mature, dry fruit consists of a hard shell surrounding a stiff, dense network of cellulose fibers (sponge) which is a good source of fiber used in industries for filter and cleaning the motor car, glass wares, kitchen utensil, bath and body bathing accessories (Oboh and Aluyor, 2009). Matured fibers are generally used in washing ships and decks and manufacturing slippers or baskets and used as shoe mats, inner cloth of bonnet. The fibrous vascular system inside the fruit after been separated from the skin, flesh and seeds, can be used as a bathroom sponge, as a component of shock absorbers, as a sound proof linings, as a utensils cleaning sponge, as packing materials, for making crafts, as filters in factories and as a part of soles of shoes (Bal et al., 2004). They can also be used for cleaning floors or cars without scratching. The small ones are softer and good for washing the face and larger ones for the body. They can also be recycled into mats or pillows when they finally wear down

(Newton, 2006). Sponge gourds are also used as absorbent (Altinisik et al., 2010). Sponge gourd struts are characterized by a microcellular architecture with continuous hollow microchannels, which form vascular bundles and yield a multimodal hierarchical pore system (Zamperi et al., 2006). The cellulose content varies from 55 to 90%, the lignin content is within the range of 10 and 23%, and the hemicelluloses content is around 8 and 22% and ash 2.4% (Satyanarayana et al., 2007; Tanobe et al., 2005).

The tender fruit used as vegetable which is easily digestible and increases appetite when consumed. The edible fresh and tender fruit contains 94 percent moisture and large number of chemical components including 16Cal per 100g with 9.5g carbohydrates, 2g of protein, 0.25g of fat, 10ug of vitamin A, 12.5mg of vitamin C besides minerals like sodium, calcium, potassium and phosphorus (2.5g, 30g, 375g and 62.5mg respectively). Besides being a vegetable, the mature, dry fruit consist of a hard shell surrounding a stiff, dense network of cellulose fibre (sponge) which is a good source of fiber used in industries for filler and cleaning the motor car, glass wares,(Obah and Aluyor, 2009).

It is an important component of crop rotation during *pre-kharif* and *kharif* seasons in North Indian condition and is cultivated both on commercial scale and in kitchen gardens. Attention to the improvement on yielding ability and other characters has been very limited which is prominent from the presence of very few varieties for commercial cultivation. Earliness is a major criterion for any crop improvement programme as it benefits the grower to reap good profit by catching the high early market price. Being monoecious and essentially cross-pollinated, it provides ample scope for successful exploitation of hybrid vigour.

Sponge gourd is an annual climber and monoecious vegetable. There is wide variability in size of fruit; ranging from a few centimeters to one meter, fruit shape and colour as traits are complex and controlled by several genes (Beyer et al., 2002; Zalapa et al., 2006). It is a cross pollinated vegetable, thus, its natural population has tremendous variability for fruit shape, colour, taste etc.

A logical way to start any breeding programme is to survey the variation in the available material. It is said that genetic variability is the "sine quanon" of any such programme. Selection is said to be effective in a population having large heritable variability. The genetic variability and its component are the genetic fraction of observed variability that provides measures of transmissibility of the variation and response to selection.

The knowledge of pattern of inheritance of various characters are important consideration while determining the most approximate breeding procedure applicable to any particular crop. The breeder's choice of the material for any improvement work consequently depends on the amount of genetic variability present. The phenotype is often not true indicator of its genotype, due to the masking effect of environment over the genotype.

The estimate of correlation coefficient analysis will be more useful in the estimation of inter-relationship among the yield contributing component and onward. An estimate of path coefficient analysis gives the indication of the nature and extent of direct and indirect effect themselves yield contributing components.

In view of the above facts, the present studies in sponge gourd entitled "Studies on genetic variability, character association and physiological analysis in sponge gourd" was carried out with the following objectives:

OBJECTIVES

1. To estimate parameters of genetic variability in sponge gourd.
2. To assess correlation coefficient between yield and its contributing characters.
3. To determine direct and indirect effect of yield component on fruit yield per vine.
4. To find out chlorophyll content index (CCI) and relative water content (RWC %).

REVIEW OF LITERATURE

The literature available on sponge gourd and some other cucurbits has been reviewed in this chapter under the following heads,

1. Genetic variability
2. Correlation coefficient
3. Path coefficient analysis
4. Chlorophyll content index (CCI)
5. Relative water content (RWC %)

Genetic variability

Genetic variability is a measure of the tendency of individual genotypes in a population to vary from one another. Variability is different from genetic diversity, which is the amount of variation seen in a particular population.

Rajput et al (1996) reported that PCV were higher than the GCV with high PCV and GCV values for seeds per fruit and yield per vine in bitter gourd.

Singh et al. (2002) studied genetic variability in 80 genotypes of ridge gourd and observed high GCV and PCV for node number for appearance of first male flower, sex ratio on whole plant, main axis and branches, fruits per plant, fruit weight, and seeds per fruit and yield per plant.

Chowdhury and Sharma (2002) found very high GCV and PCV for vine length and fruit weight in ridge gourd. The magnitude of phenotypic coefficient of variation (PCV) was greater than corresponding genotypic coefficient of variation (GCV) for all traits under study.

Singh et al. (2002) recorded higher genotypic coefficient of variation for total yield, average fruit weight and observed for node at which first female flower appeared followed by number of nodes per plant, weight of fruit, number of fruits per plant and number of branches per plant in pointed gourd.

Karuppaiah et al. (2002) found high GCV for number of female flowers per plant, yield per plant, and number of fruits per plant and flesh thickness in ridge gourd.

Rao et al. (2002) observed high PCV with equally high GCV in yield per vine, fruit per vine, fruit per branch and node of first male flower indicating maximum variability existing in the genotypes of ridge gourd.

Rahaman et al. (2002) evaluated 24 genotypes of snake gourd and revealed high genotypic coefficient of variation for fruit yield (35.52), number of fruits per plant (34.95), fruit length (27.37), stem length (20.70) and flesh thickness (15.38).

Narayanankutty et al. (2006) studied 36 snake gourd genotypes and observed the highest range of variations for fruit yield, fruit weight, seeds/fruit and fruit length. The seeds per fruit, fruit yield, fruit weight and fruits per plant showed highest phenotypic and genotypic coefficient of variation. High values of GCV are an indication of high genetic variability among the genotypes and the scope for improvement of these characters through simple selection.

Bharathi et al. (2006) assessed reported that genetic variability for 10, characters in 32 genotypes of spine gourd. PCV ranged from 15.26% for fruit girth to 34.28% for fruit weight, while GCV ranged from 14.38% for fruit girth to 33.52% for fruit weight.

Sheng et al. (2007) revealed those fruit length and fruit perimeters were simultaneously affected by fruit direct genetic effects and maternal effects. Fruit direct genetic effects were relatively more important for fruit shape traits at whole developmental period. The gene expression was most active at the economical maturation stage (1-12 day after flowering) for two shape traits, and the activation of gene was mostly due to direct dominance effects at physiological maturation stage (13-60 day after flowering). The coefficients due to different genetic effects, as well as the phenotypic correlation coefficients, varied significantly between fruit shape traits themselves at various maturation stages.

Yadav et al*.* (2008) studied bottle gourd cultivars based on nine characters *viz;* days to first male flowering, days to first female flowering, number of nodes of first male flowering, number of nodes of first female flowering, days to edible fruit, fruit length, fruit width, number of fruits per plant and yield per plant. All the characters showed considerable amount of variability. The fruit width had the highest coefficient of genotypic and phenotypic variability.

Singh et al. (2008) evaluated 110 diverse genotypes of ridge gourd and recorded highest values of GCV and PCV for fruit weight (43.70 & 43.86) followed by number of nodes to first male flower (41.43 & 42.77), fruit yield per plant (40.90 & 42.59).

Islam et al. (2009) evaluated 20 bitter gourd genotypes and revealed that wide genetic variation was observed among genotypes for branches per vine, yield per vine and number of fruits per plant. High genotypic coefficient of variation (GCV) was observed for branches per vine yield per plant and number of fruits per vine whereas low genotypic coefficient of variation was observe days to first male and female flowering.

Sureja et al., (2010) In an investigation of 72 F_1 hybrids and their 9 parents of ash gourd found greater estimates of genetic advance as percentage of mean coupled with high amount of heritability for yield per vine, number of fruits per vine and number of seeds per fruit indicating that these traits are governed by additive genes and continued selection would be helpful in modifying the mean performance of the population.

Husna et al. (2011) studied 31 genotypes of bottle gourd and found that high genotypic coefficient of variation (GCV) was observed for yield per plant, fruit weight whereas; low genotypic coefficient of variation was observed fruit breadth. In all cases, phenotypic variances were higher than the genotypic variance. Differences between genotypic and phenotypic coefficient revealed that the major portion of the phenotypic variance was genetic in nature.

Kumar et al. (2013) reported highest genotypic and phenotypic variations for total yield per vine followed by number of seeds per fruit, average weight of fruit and total soluble solids. Number of seeds per fruit, average weight of fruit and specific gravity showed high heritability with high genetic advance.

Shutharshan et al. (2013) reported that the Sponge gourds, the fruit of Luffa cylindrica, are widely used throughout the world. It is an annual climbing crop which produces fruit containing fibrous vascular system. It is considered as an important medicinal plants.

Koppad et al. (2015a) evaluated eighteen genotypes of ridge gourd for growth, earliness, biochemical, yield and fruit quality parameters. The results revealed that high heritability with moderate to high GCV, PCV and GAM (Genetic advance over mean) was recorded for chlorophyll and proline during 45 days DAS and total yield per vine indicated that these characters could be improved by simple selection.

Koppad et al. (2015b) evaluated eighteen genotypes of ridge gourd for physiological, yield, quality, and fruit characters under the field condition revealing that PCV was higher than the GCV for most of the traits. High heritability with moderate to high GCV and genetic gain was recorded for leaf area, leaf area index and specific leaf weight at 45 days DAS, absolute growth rate, crop growth rate, relative growth rate of leaf, tendril and vine at 45-90 DAS, number of fruits per vine and yield per vine indicating that these characters could be improved by simple selection.

Correlation coefficient

Correlation coefficient analysis measures the mutual relationship between various plant characters and determines the component characters on which selection can be based for improvement in yield. Simple correlations are of three types *viz.,* phenotypic, genotypic and environmental. Phenotypic correlation is the observable correlation between variables, measures the environmental deviation together with no additive gene action. Genotypic correlation on the other hand is the inherent association between two variables. They can be estimated from replicated data only.

The knowledge of the nature of association between characters is of great asset to plant breeders to formulate evaluation or work procedures. The magnitude and direction of association is measure by correlation coefficients.

Badade et al. (2001) observation was recorded for 14 quantitative characters, yield was found significantly and positive correlated with number of branches per vine. Percentage of female flowers and number of fruit per vine was found significantly and negative correlated with days to first male and female flower appearance and weight of deformed fruits per vine at both phenotypic and genotypic levels in bottle gourd.

Dora et al. (2002) evaluated eleven selections of pointed gourd and revealed that yield plant was significantly and positively correlated with number of fruits per plant, fruit set percentage, and fruit retention. Number of branches per plant, diameter of fruit, fruit length and days taken fruit set to marketable maturity showed significantly and positive correlation with yield per plant.

Dey et al. (2005) conducted in 38 indigenous genotypes of *M. charantia* for 17 traits. The genotypic correlation coefficients were greater than the phenotypic correlation coefficients. Fruit yield was most positively correlated with fruit weight, followed by number of fruits per plant, flesh thickness, number of days from fruit set to maturity, fruit index, fruit length and fruit diameter. The number of male flowers per plant, ascorbic acid content, total carotenoid content, number of days to the appearance of the first male and female flowers, and node on which the first female flower appeared were negatively correlated with yield.

Narayankutty et al. (2006) revealed that yield was strongly correlated with fruit weight, fruits per vine, fruit girth, days to first harvest, flesh thickness and days to first female flower opening in snake gourd.

Gupta and Partap (2007) evaluated thirty-six hybrids and nine parents in half diallel crossing (no reciprocals) for correlation and path analyses to study the different qualitative and quantitative traits of bitter gourd fruits. Significant positive correlations were observed for fruit length with number of fruits per plant, average fruit weight and total fruit yield per vine.

Kumar et al. (2007) observed that the value of correlation at genotypic level was higher than the phenotypic correlations, indicating that there is strong inherent association between the various characters studied. The fruit yield per vine showed positive and significant correlation with number of branches per vine, vine length, node number of first female flower, length of edible fruits, number of fruits per vine, number of seeds per fruit and 100 seed weight at genotypic and phenotypic levels. This indicated that fruit yield can be improved by making selection on the basis of number of branched vine, vine length, nodes number of first female flower, length of edible fruit and number of fruits per vine.

Khan et al. (2009) revealed that number of node at first harvest had positive association with fruit weight, number of fruits per plant and yield of fruits per hectare where as negative correlation with fruit length and weight of fruits per plant in 24 pointed gourd accessions.

Rahman et al. (2010) studied eleven genotypes in sweet gourd for 14 quantitative and two qualitative components. Correlation studies in relation to various characters revealed that total fruit yield/vine was positively and significantly correlated to fruit weight, fruit length, fruit diameter, fruit girth and protein content. Days to first female flower appearance which reflects the earliness to fruiting was positively and significantly associated with days to first male flower appearance and pedicel length. Among the biochemical traits, protein content showed significant and positive correlation with fruit weight, fruit length, fruit diameter, fruit girth and total fruit yield/ vine.

Khule et al. (2011) revealed that marketable fruit yield per plant exhibited significant positive correlation with number of fruits per plant and fruit length. In general, genotypic correlation coefficient were higher than the corresponding phenotypic correlation coefficient suggesting that environment influence reduces the relationship between yield and yield contributing characters of sponge gourd. Path coefficient analysis showed that number of fruit per plant, days to appear first female flower, fruit length, fruit diameter, number of seeds per fruit and 100 seed weight had direct positive effect on marketable fruit yield per plant. This indicates that this character was the major contributor to fruit yield.

Emina et al. (2012) studied 40 diverse genotypes of bottle gourd and reported positive correlation of plant height with fruit length, seeds per plant and 100 seed mass where as negative correlation with fruit weight.

Narayan et al. (2012) found the fruit yield per vine showed positive and significant correlation with number of branches per vine, vine length, node number of first male flower, node number of first female flower, length of edible fruits, number, fruits per vine, number of seeds per fruit and 100-seed mass at genotypic and phenotypic levels in 10 diverse bottle gourd entries

Aliya et al. (2014) investigated correlation in fifty genotypes of spine gourd. Phenotypic and genotypic correlation coefficient analysis revealed that the fruit yield was positively and significantly correlated with the vine length, number of stems per plant, days to last fruit harvest, fruiting period, fruit length, fruit width, fruit weight and number of fruits per plant. Significantly negative correlation was observed between days to first fruit harvest and fruit yield per plant.

Path coefficient analysis

Knowledge of inter-character relationships is very important in plant breeding for indirect selection of Characters that are not easily measured and for those that exhibit low heritability. Correlation studies between characters have also been of great value. In the determination of the most effective breeding procedures as the number of independent characters affecting a dependent character increases, there is bound to be some amount of interdependence. Under such a complex situation, correlation alone becomes insufficient to explain relationships among the characters. Path analysis permits identification of direct and indirect causes of association and measures the relative importance of each character.

The literature the direct and indirect effects of various quantitative traits on fruit yield of cucurbits reviewed hereunder.

Rahaman et al. (2002) recorded highest positive direct effect for number of fruits followed by average fruit weight in snake gourd.

Umamaheshwaraapa et al. (2004) reported that in bottle gourd path coefficient analysis revealed that number of fruits per vine had maximum direct effect on fruit yield followed by fruit weight.

Narayanankutty et al. (2006) studied 36 snake gourd genotypes and results revealed that fruit weight and number of fruits per plant had the maximum positive direct effect on yield and the indirect contribution of other characters like days to first harvest, seeds per fruit and 100 seed weight.

Islam et al. (2009) studied 20 bitter gourd genotypes and the results revealed that number of fruits per plant had the maximum direct effect (1.789) followed by vine length (m) (1.134), number of nodes per vine (0.583) and days to first flowering male (0.044). The contribution of yield components like fruit length (cm), number of nodes per vine and days to first male flowering were higher.

Khan et al. (2009) studied 24 accessions of pointed gourd and results revealed that days to first flowering had highly negative direct effect (-0.187) on yield per plant whereas fruit length (0.482), fruit breadth (1.348) and fruit weight (0.331) had positive direct effect on yield per plant.

Husna et al. (2011) reported that exhibited maximum direct contribution towards yield per plant with of number of fruits per plant (0.680) followed by fruit weight (0.453) in reported 31 bottle gourd genotypes.

Pandey et al. (2012) reported that days to first marketable fruit harvest exerted significant and positive association with days taken for anthesis of first female flower and days taken for anthesis of first male flower. The path coefficient analysis revealed average fruit weight, number of fruit per plant and days to first marketable fruit harvest had positive direct effect on marketable fruiting yield per plant.

Chlorophyll content index (CCI)

Kapur (1999) reported that light shows detriment's effect on the chlorophyll concentration .The plants grown in less light intensity show higher chlorophyll content compared to those grown in higher light intensity in *Andrographis paniculata.*

Haque et al. (2009) reported that chlorophyll content was converted to dry weight basis using leaf dry matter percentage.

Alaei (2011) evaluating the effect of amino acids on leaf chlorophyll content in bread wheat genotypes under drought stress conditions at germination stage, using 11 wheat genotypes at 6 conditions and three replications. . Results showed that with increasing Chlorophyll content seed yield was increased. Also results showed that using Fosnotren Solution in irrigation condition can be useful for increasing yield and resistance to drought stress.

Koppad et al. (2015a) reported that number of leaves might have lead to the more amount of chlorophyll accumulation in the particular genotype and lead to the more yield.

Relative water content (RWC %)

Ibrahim and aldesuquy (2003).The economic yield was found to be strongly and positively correlated with RWC.

Min and Bartholomew (2005) Similar reduction in relative water content (RWC) has been reported under flooding stress in pineapple.

Arjenaki e al. (2012) reported that rate of RWC in plant with high resistance against drought is higher than others. In other words, plant having higher yields under drought stress should have high RWC.

Pramod Kumar et al. (2013) suggested that the water logging significantly reduced the relative water content (RWC) and membrane stability particularly in sensitive mungbean genotypes.

Hayatu et al. (2014) recorded that leaf relative water content of the water stressed genotypes were lower than the unstressed genotypes. At vegetative stage of water stress only 22.22% had an increase in their leaf relative water content and 77.78% recorded reduction in their leaf relative water content.

MATERIALS AND METHODS

This chapter comprises the details about the materials used and the methods adopted during the course of present investigation entitled “Studies on genetic variability, character association and physiological analysis in sponge gourd" was carried out in Kharif season during the year 2015-16.

3.1 Experimental site

The present experiment was laid out in the research field of KVK, Jawahar Lal Nehru Krishi Vishwa Vidyalaya, Jabalpur during Kharif season, 2015-2016. The land topography of the experimental site was almost uniform with an adequate surface drainage. The internal drainage of the experimental site is medium.

3.1.1 Soil

The soil of the experimental field was clay loam with good drainage and uniform texture with medium NPK status.

3.1.2 Climate and weather condition

The field of experimental farm, Jabalpur is situated on 'Kymore plateau' agro-climate region of Madhya Pradesh at 23.9° North latitude, 79.50 East longitudes and on an altitude of 411.78 meters above the mean sea level. The tropic of cancer passes through the middle of the district. The climate of region is typically semi arid and sub tropical having extreme winter and summer. The average annual rainfall is 1350mm, which is mostly received during June to October from South-west monsoon. The average maximum temperature is 46°c and minimum temperature 6.8^{0}C. The average annual relative humidity is 74%.

The meteorological parameters during the crop season such as minimum and maximum temperature, sunshine hours, rainfall number of rainy days and relative humidity were recorded at Meteorological observatory Krishi Nagar, JNKVV, Jabalpur are presented in Table 3.1.

Table 3.1: Meteorological information (week wise) during entire crop season of the year August 2015 to November 2015 at Jabalpur

Meteo. Weeks.	Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)	No. of rainy days	Sun shine (hrs.)
	Max.	Min.	Mor.	Evn.			
33	31.2	24.5	91	73	116.8	04	03.0
34	31.3	23.6	88	64	009.4	01	07.4
35	30.4	22.9	93	76	104.6	05	03.0
36	32.2	24.2	87	57	008.2	01	06.7
37	33.5	23.1	91	53	003.4	01	08.4
38	32.0	23.7	92	64	070.2	0.3	05.6
39	32.6	21.1	84	45	000.0	00	09.2
40	33.1	19.5	88	35	000.0	00	09.3
41	35.1	17.9	86	31	000.0	00	09.5
42	34.0	19.0	86	36	000.0	00	09.2
43	33.3	18.4	87	47	000.0	00	06.9
44	28.0	17.0	92	58	040.0	01	05.8
45	31.4	17.9	88	40	000.0	00	05.8
46	30.9	14.1	89	35	000.0	00	07.6
47	29.0	12.6	89	36	000.0	00	06.7
48	30.8	14.5	88	34	000.0	00	07.2

3.2 Experimental materials

The experimental materials for this study comprised 15 genotypes (14 genotypes with 1 check) are presented in Table 3.2

Table 3.2: Detail of genotypes used in the study

S. No.	Name of genotype	Source /institutes
1.	VASUDHA 175	UPL, limited
2.	PRIYA	UPL. Limited
3.	SG101	UPL. Limited
4.	SG102	UPL. Limited
5.	VIDHYA172	UPL. Limited
6.	SG103	UPL. Limited
7.	SG104	UPL. Limited
8.	VRSG8	IIVR, Varanasi
9.	VRSG2/13	IIVR, Varanasi
10.	VRSG2/14	IIVR, Varanasi
11.	VRSG68-1	IIVR, Varanasi
12.	VRSG140	IIVR, Varanasi
13.	VRSG182	IIVR, Varanasi
14.	NS441	IIVR, Varanasi
15.	KASHI DIVYA (CHECK)	IIVR, Varanasi

3.3 Experimental details

3.3.1 Design of Experiment

The experiment was laid out in Randomized Complete Block Design (RCBD) with 15 treatments (14 genotypes+ 1 check) in three replication. The experiment details are as follow:

Design	:	RCBD
Replication	:	Three
Genotypes/ treatments	:	15
Number of plots	:	45
Plot size	:	11.20× 1.00
Row to row distance	:	1.5 m
Vine to vine distance	:	80 cm
Number of rows per plot	:	1
Number of vines per row	:	11
Gross area of experimental field	:	1188 sq.m
Net area of experiment field	:	504 sq.m
Number of vines for observation per plot	:	5
Distance between replication	:	1m
Crop	:	Sponge gourd
Season	:	*Kharif (*2015-16)
Date of sowing	:	26 august 2015
Manures	:	20 tonnes FYM/ha
Fertilizer doses (N:P:k)	:	60:40:30 kg/ha

3.3.2 Field preparation and layout

3.3.2.1 Sowing

In order to get good tilth of the soil for sowing one cross cultivation was done by tractor drawn cultivator followed by two harrowing and one ploughing and plastic mulch also apply before sowing of seed. In the beginning of the experiment, seeds were dibbled.

3.3.2.2 Thinning

After two weeks of sowing, thinning was carried out to maintain vine to vine distance. All the recommended package of practices was followed to raise healthy crop.

3.3.2.3 Irrigation

The irrigation was given by the drip irrigation system when required.

3.3.2.4 Intercultural operations

The experimental plots were kept weed free. Hand weeding was done as and when needed.

3.3.2.5 Vine protection

The crop was sprayed with Imidacholoroprid 17.8% SL and Trizophas 40 EC alternate to keep the crop free from pest during crop growth period.

3.3.2.6 Fertilizer application

A dose of 60kg N, 40kg P_20_5 and 30kg K_20/ha along with 20 tonnes FYM/ha was applied. One third nitrogen and entire quantity of P, K and FYM was applied prior to sowing. Remaining dose of nitrogen was applied in two splits at 30 and 60 days after sowing.

3.3.2.7 Sampling

Sampling was done after 15 days to harvest time for growth analysis. Five vines were randomly selected from each genotype for the study.

3.4 Observation

The data recorded on various parameters were subdivided into five categories during the period of experimentation.

(A) Morphological parameters

3.4.1 Vine length (cm)

Height of vine was recorded from the base just above the soil surface to growing point of the vine with the help of meter scale. The height was recorded at (i) 15 days after sowing (ii) 30 days after sowing (iii) 45 days after sowing.

3.4.2 Number of leaves per vine

Number of leaves of selected vines was counted and average was worked out at (i) 15 days after sowing (ii) 30 days after sowing (iii) 45 days after sowing.

3.4.3 Number of branches per vine

Number of branches of selected vines was counted and average was worked out at (i) 15 days after sowing (ii) 30 days after sowing (iii) 45 days after sowing.

(B) Phenological parameters

3.4.4 Days to first staminate flower

Average number of days required to first staminate flower in each genotype was recorded separately.

3.4.5 Days to first pistillate flower

Average number of days required to first pistillate flower in each genotype was recorded separately.

3.4.6 Number of nodes to first staminate flower

Numbers of nodes were counted at the time of first staminate flower.

3.4.7 Number of nodes to first pistillate flower

Numbers of nodes were counted at the time of first pistillate flower.

3.4.8 Days to first harvest after sowing

Average number of days required to first harvest after sowing in each genotype was recorded separately.

3.4.9 Days to first harvest after anthesis

Average number of days required to first harvest after anthesis in each genotype was recorded separately.

3.4.10 Sex ratio (Staminate :Pistillate)

Number of staminate and pistillate flower was counted in each genotype separately and estimates sex ratio.

3.4.11 Number of staminate flower per vine

Average number of staminate flowers was counted in each genotype separately.

3.4.12 Number of pistillate flower per vine

Average number of staminate flowers was counted in each genotype separately.

(C) Physiological parameters

3.4.13 Chlorophyll content index (CCI)

The SPAD-502, a hand held chlorophyll meter was used for rapid and non-destructive estimation of chlorophyll in leaves. This instrument uses a silicon photo-idiode to detect transmittance of light emitted by two light emitted diodes through a leaf sample, one with peak emittance at 650 nm where absorbance by chlorophyll is high and relatively unaffected by carotene and one with peak emittance at 940 nm where absorbance by chlorophyll is negligible. Chlorophyll content was measurement in different portion of the 5^{th} leaf from the top (fully expended leaflet) at 15, 30 and 45 DAS and expressed as SPAD units.

3.4.14 Relative water content (RWC %)

Relative water content (RWC) is the appropriate measure plant water status in term of the physiologically consequence of cellular water deficit (Barse and Weatherley 1962). Leaf relative water content was estimated by fresh weight, turgid weight of fresh leaf sample (4 mm diameter leaf discs) by keeping in water 4 hrs, following by drying in hot air oven till constant weight is achieved. RWC (%) was calculated by formula.

$$\text{RWC(\%)} = \frac{\text{Fresh Weight} - \text{Dry Weight}}{\text{Turgid Weight- Dry Weight}} \text{ X } 100$$

(D) Fruit characters

3.4.15 Fruit shape

The shape of fruit was recorded from obtained randomly selected vine from every genotype.

3.4.16 Fruit skin texture

The skin of the fruit was recorded in following stage:

- Striped
- Non striped
- Spotted

3.4.17 Fruits Skin colour

The colour of the fruits was recorded at marketable stage in following categories.

- Light green
- Green
- Dark green

3.4.18 Fruit Strip colour

The Strip colour of the fruits was recorded at marketable stage in following categories.

- Absent
- White
- Green
- Yellow

3.4.19 Fruit bitterness

Bitterness of the fruit was recorded at marketable stage in following categories.

- Absent
- Low
- Medium
- High

3.4.20 Vine growth habit

Vine growth habit was recorded in following categories:

- Short
- Medium
- Long

(E) Yield parameters

3.4.21 Fruit girth (cm)

The girth of the fruit was recorded from selected vine with the help of Vernier calipers and average was worked out.

3.4.22 Fruit length (cm)

Length of the fruit (cm) was measured from the scale at edible maturity stage.

3.4.23 Number of fruits per vine

The number of fruits harvested from five randomly selected vines in each genotype was collected during each picking counted and totaled together and average fruits per vine were calculated.

3.4.24 Fruit Yield per vine (kg)

Picking of fresh marketable fruits was done from the observational vines separately throughout the harvesting period at an interval of 2 days. It was totaled and then average yield per vine was worked out for each genotype.

3.4.25 Fruit yield per plot (kg)

Picking of fresh marketable fruits was done from the observational vines separately throughout the harvesting period at an interval of 2 days. It was noted for all the pickings.

3.4.26 Fruit yield per hectare (q)

The weight of fruits harvested was pooled and average fruit yield/ha was calculated by multiplication of the number of vine per plot and per hectare.

3.5 Statistical methodology

The data obtained in respect of all the characters has been subjected to the following statistical analysis.

3.5.1 Mean:

It was calculated by using following formula.

$$\text{Mean} = \frac{\sum x}{n}$$

where,

Σx = The sum of all the observations

n = Number of observations

3.5.2 Analysis of variance

The data based on the mean of individual vines selected for observations were statistically analysed to find out overall total variability present in the material under study for each character and for all the populations. The first and foremost step is to carry out analysis of variance to test the significance of differences among the populations. The skeleton of analysis of variance used was as follows:

Table 3.3: ANOVA for Randomized Completely Block Design

Source of Variation	d.f.	Sum of square	Mean sum of square	F value	F_t 5% or 1% table value
Replication	r-1	RSS	RMS	RMS/EMS	-
Genotypes	g-1	GSS	GMS	GMS/EMS	-
Error	(r-1) (g-1)	ESS	EMS	-	-
Total	**rg-1**	**TSS**	**-**	**-**	**-**

where,

r = Number of replications

g = Number of genotypes

d.f. = Degree of freedom

RSS = Replication sum of squares

GSS = Genotype sum of squares

ESS = Error sum of squares

TSS =Total sum of squares

RMS = Replication mean sum of squares

GMS = Genotype mean sum of square

EMS = Error mean sum of square

A significant value of F test indicates that the test entries differ significantly among themselves, which require the computing of C.D.

$$C.V. = \frac{\sqrt{EMS}}{GM} X100$$

$$SEm\pm = \frac{\sqrt{EMS}}{r}$$

$$\text{SE diff} = \frac{\sqrt{2EMS}}{r}$$

CD at 5% prob. Level = SE diff x $t_{5\%}$ table value at error d.f

where,

C.V. %	=	Coefficient of variation
SEm±	=	Standard error of means
S E diff	=	Standard error of difference of mean
GM	=	Grand mean
C.D.	=	Critical difference
t 5%	=	table value of t at 5% probability level at error d.f.

Estimation of mean, components of variance, phenotypic, genotypic and environmental coefficient of variation, heritability, genetic advance and genetic advance as percentage of mean:

The mean of different characters were calculated by conventional method:-

$$\text{Mean} = \frac{\sum x_i}{N}$$

where,

Σx_i	=	The sum of all the observation for i^{th} character.
n	=	Number of observations.

Range was recorded by observing the lowest and the highest mean values for each character.

The component of variance was calculated as follows:-

Source of variation	**M.S.S.**	**Expected M.S.S.**
Replications	-	-
Genotypes	M_i	$\sigma^2_{ei} + r.\ \sigma^2_{gi}$
Error	E_i	σ^2_{ei}

$$\sigma^2_{gi} = M_I - E_i$$

$$\sigma^2_{ei} = E_i$$

$$\sigma^2_{pi} = \sigma^2_{gi} + \sigma^2_{ei}$$

where,

σ^2_{gi} = Genotypic variance for i^{th} character.

σ^2_{ei} = Environmental variance for i^{th} character.

σ^2_{pi} = Phenotypic variance for i^{th} character.

Phenotypic and genotypic coefficient of variation (expressed in %) were calculated by using the formula given by Burton (1952). Genotypic coefficient of variation (GCV) was calculated as below:

$$GCV\% = \frac{\sqrt{\sigma^2 g_i}}{\overline{X}_i} X100$$

Phenotypic coefficient of variation (PCV)

$$PCV\% = \frac{\sqrt{\sigma^2 P_i}}{\overline{X}_i} X100$$

where,

$\overline{X}_i$ = General mean of the i^{th} character under consideration.

σ^2_{gi} and σ^2_{pi} = Genotypic and phenotypic variances of the i^{th} character respectively.

Heritability and genetic advance

Heritability (broad sence) which is ratio of genotypic variance to the total phenotypic variance is symbolized as h^2 (BS) and expressed in percentage. Estimation of heritability was done as per the formula given by Hanson *et al*. (1956).

$$h^2 \text{ (BS)} = \frac{\sigma^2 g_i}{\sigma^2 p_i} \times 100$$

or

$$= \frac{\text{Genotypic variance of the } i^{th} \text{ character}}{\text{Phenotypic variance of the } i^{th} \text{ character}}$$

Expected genetic advance was calculated by using the method suggested by Johnson *et al.* (1955) at 5% selection intensity.

Genetic advance (GA) = K. P_i .h^2_i

Genetic advance as percentage of mean was calculated as follows:

$$\frac{\text{Genetic advance}}{\overline{X}}$$

where,

K= Selection intensity its value at 5% selection level is 2.06.

P_i = Phenotypic standard deviation of the i^{th} character.

h^2_i = Broad sense heritability (fraction) of the i^{th} character.

$\overline{X}_i$ = General mean of the i^{th} character under consideration.

Correlation coefficients

Correlation coefficients were calculated in all possible combinations taking all the characters into consideration at genotypic, phenotypic and environmental levels by using the formula as proposed by Miller *et al.* (1958).

$$r = \frac{\sum xy - \frac{\sum xy}{n}}{\sqrt{\left(\sum x^2 - \frac{(\sum X)^2}{2}\right)\left(\sum y^2 - \frac{(\sum y)^2}{n}\right)}}$$

where,

r	=	Correlation coefficient
n	=	Number of treatments
X and Y	=	Characters under study

Genotypic, phenotypic and environmental correlations were computed by substituting corresponding variance and covariance in the above formula, e.g.

$$r_G\ (Xi\ Xj) = \frac{\text{Cov G (Xi Xj)}}{\sqrt{\text{VG (Xi). VG (Xj)}}}$$

$$r_P\ (Xi\ Xj) = \frac{\text{Cov P (Xi Xj)}}{\sqrt{\text{VP (Xi). VP (Xj)}}}$$

$$r_E\ (Xi\ Xj) = \frac{\text{Cov E (Xi Xj)}}{\sqrt{\text{VE (Xi). VE (Xj)}}}$$

Testing of correlation coefficient:-

The phenotypic correlations were tested for their significance by using the following formula based on "t" test:

$$t = \frac{r}{\sqrt{(1-r^2)}}\sqrt{n-2} \text{ at (n-2) d.f}$$

where,

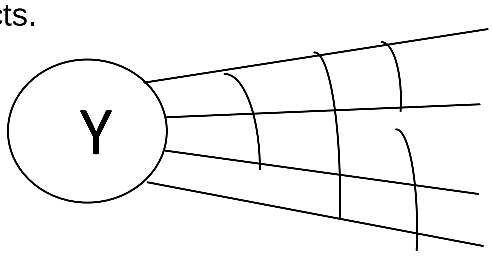
n = Number of treatments.

r = phenotypic correlations coefficient.

The calculated value of "t" is compared with table of "t" at (n-2) d.f. If the calculated value is equal to or greater than table value, it is significant at given probability level. If $t_c < t_T$, it is non significant.

3.4.3 Path coefficient analysis:

Path coefficient are standardized partial regression coefficient and as such these provide the means to direct influence of one character upon another character upon another character and also permit portioning of correlation coefficient into direct and indirect effect via other character. The direct indirect contribution of various independent character on a dependent character yield were calculated through path coefficient analysis as suggested by Wright (1921) and elaborated by Dewey and Lu (1959). The following set of simultaneous equation were formed and used for the estimation of direct and indirect effects.



$r_{1y} = p_{1y} + r_{12}\ p_{2y} + r_{13}\ p_{3y}$ + -- $r_{1y}\ p_{1y}$

$r_{2y} = r_{2y}\ p_{1y} + r_{2y} + r_{23}\ p_{3y}$ + -- $r_{21y}\ p_{1y}$

$r_{ky} = r_{ki}\ p_{1y} + r_{k-1}\ p_{2y} + r_k^{3}\ p_{3y}$ + -- p_{ky}

$r_{xky} = r_{xk1}\ p_{1y} + r_{xk2}\ p_{2y} + r_{xk3}\ p_{3y}$ + --------------------------------------- p_{xky}

where,

r_{xky} = Coefficient correlation between independent character

P_{iy} to P_{3y} = Direct effect of character 1 to 3 character y

Direct effect

The direct effects were calculated as follows

$$P_{ky} = \sum_{I=1}^{K} C_{kirk}\ Y$$

Indirect effect

Indirect effect of any independent traits on the dependent one (=yield) via other independent traits are computed by multiplying the direct effects (Pky) of that independent variables with the corresponding correlation coefficient as follows:

K^{th} traits via (n-1) = rk (n-1) P (n-1) Y

RESULTS

This chapter describes the results of the present study. It has been organized according to the objectives for convenience of interpretation and presented under the following heads.

4.1 Analysis of variance

4.2 Mean performance of variety/genotype

4.3 Chlorophyll content index

4.4 Relative water content

4.5 Genetic variability

4.6 Heritability and genetic advance

4.7 Correlation coefficient

4.8 Path coefficient

4.1 Analysis of variance

The analysis of variance was carried out separately for all the eighteen characters and presented in Table 4.1 viz., vine length (cm) (15,30 and 45 DAS), number of leaves per vine (15,30 and 45 DAS), number of branches per vine (15,30 and 45 DAS),days to first flowering, number of nodes at which first appearance staminate flower, number of nodes at which first appearance of pistillate flower, number of staminate flower per vine, number of pistillate flower per vine, days to first harvesting after anthesis, days to first harvest after sowing, sex ratio, chlorophyll content index (15,30 and 45 DAS), relative water content (%) (30 and 45 DAS), number of fruits per vine, length of fruit (cm), girth of fruit (cm), average fruit weight (g), fruit set percentage, fruit yield per vine(kg), fruit yield per plot(kg), fruit yield per hectare(q). The analysis of variance revealed significant differences among genotypes for all the characters under study.

APPENDICES

Analysis of variance for various characters in sponge gourd (mean sum of squares).

Source of variance	D.F.	Vine length (cm)			No. of leaves/vine		
		15 DAS	30 DAS	45DAS	15 DAS	30 DAS	45DAS
Replications	2	448.578	3217.034	11597.071	2.305	427.720	122.823
Genotypes	14	2785.181**	2708.047**	4205.875**	31.891**	125.175**	106.602**
Error	28	67.911	337.708	293.701	3.839	10.227	5.214

Source of variance	D.F.	No. of branches/vine			Days to first flowering	
		15 DAS	30 DAS	45DAS	Staminate	Pistillate
Replications	2	0.124	0.032	0.017	0.228	0.124
Genotypes	14	0.568**	0.340**	1.617**	3.180**	4.153**
Error	28	0.019	0.049	0.016	0.404	0.406

Source of variance	D.F.	No. of nodes at which first flower appearances		Days to first harvest	
		Staminate	Pistillate	After sowing	After anthesis
Replications	2	0.099	7.668	7.198	1.662
Genotypes	14	2.241**	6.836**	7.960**	1.370**
Error	28	0.115	1.634	0.280	0.071

Source of variance	D.F.	No. of flower/vine		Sex ratio (staminate: pistillate)
		Staminate	Pistillate	
Replications	2	47.639	2.592	0.123
Genotypes	14	6696.246**	81.278**	0.811**
Error	28	36.300	2.136	0.087

Source of Variance	D.F.	Chlorophyll content index (CCI) SPAD			Relative water content (RWC %)	
		15 DAS	30 DAS	45DAS	30 DAS	45DAS
Replications	2	5.286	31.598	133.046	14.681	0.502
Genotypes	14	115.254**	116.518**	107.434**	61.227**	51.924**
Error	28	28.935	5.255	21.509	5.570	10.079

Source of Variance	D.F.	Number of fruits/vine	Fruit length (cm)	Fruit girth (cm)	Average fruit weight (g)
Replications	2	73.360	2.405	0.001	190.822
Genotypes	14	54.953**	44.553**	0.218**	689.047**
Error	28	5.623	5.540	0.001	75.004

Source of Variance	D.F.	Fruit set (%)	Fruit yield /vine (kg)	Fruit yield /plot (kg)	Fruit yield/ha (q)
Replications	2	10.563	3.334	9.098	723.977
Genotypes	14	101.220**	0.601**	47.209**	3756.121**
Error	28	22.878s	0.082	1.100	87.608

The performance of fifteen sponge gourd genotypes for all the characters under study is presented in Table 4.2

Table 4.2a: Mean performance of morphological parameters of sponge gourd

Genotypes	Vine length (cm)			No. of leaves/vine			No. of branches/vine		
	15 DAS	30 DAS	45DAS	15 DAS	30 DAS	45DAS	15 DAS	30 DAS	45DAS
Vasudha 175	151.41	248.66	323.38	16.82	36.33	67.50	3.06	3.50	4.83
Priya	134.27	242.29	325.88	16.81	39.86	69.19	2.20	2.80	3.83
SG101	91.55	226.90	329.22	12.45	39.13	75.70	2.60	3.20	4.57
SG102	101.69	214.56	318.44	14.07	37.86	75.66	2.29	3.06	4.31
VIDHYA172	117.08	242.87	335.11	10.03	35.26	66.03	2.18	2.33	3.17
SG103	63.38	201.73	226.55	14.42	48.40	78.62	3.60	3.66	5.67
SG104	68.12	300.73	381.44	10.20	48.19	78.14	3.16	3.26	4.83
VRSG8	86.00	292.07	327.74	10.59	45.46	81.23	3.26	3.43	5.00
VRSG2/13	106.09	273.00	373.37	15.21	53.13	83.45	3.20	3.60	5.17
VRSG2/14	73.76	261.53	349.32	10.48	51.93	80.57	2.80	3.13	5.17
VRSG68-1	129.41	276.00	367.69	17.00	47.06	83.98	2.80	3.13	4.83
VRSG140	162.44	305.80	382.47	21.60	56.20	84.08	3.00	3.20	5.47
VRSG182	104.80	255.53	332.08	14.40	49.33	80.26	3.18	3.26	5.24
NS441	68.55	249.47	323.87	11.25	41.00	74.57	2.33	2.86	3.47
KASHI DIVYA (C)	102.22	270.13	337.14	13.40	46.33	71.31	2.73	3.06	5.31
S.Em±	4.76	10.61	9.89	1.13	1.85	1.32	0.08	0.13	0.08
C.D.5% level	13.78	30.73	28.66	3.28	5.25	3.82	0.23	0.37	0.22

4. 2.1 Vine length (cm) in Sponge gourd

Vine length varied from 63.38 to 162.44 cm, 201.73 to 305.80 cm and 226.55 to 382.47cm with over all mean performance of 104.05 cm, 257.41 cm and 314.04 cm at 15, 30 and 45 DAS respectively. Genotype VRSG140 was recorded the maximum vine length 162.44 cm, 201.73 cm and 382.47cm, while the genotype SG103 proved to be dwarf one recording 63.38 cm, 201.73 cm and 226.55 cm length among all the genotypes studied at 15, 30 and 45 DAS respectively.

4. 2.2 Number of leaves per vine in Sponge gourd

Number of leaves per vine varied from 10.20 to 21.60, 35.26 to 56.20 and 66.03 to 84.08 with over all mean performance of 13.91, 45.03 and 76.68 at 15, 30 and 45 DAS respectively. Genotype VRSG140 was recorded the highest number of leaves 21.60, 56.20 and 84.08, while the genotype Vidhya172 proved to be lowest number of leaves recording 10.20, 35.26 and 66.03 among all the genotypes studied at 15, 30 and 45 DAS respectively.

4.2.3 Number of branches per vine in sponge gourd

Number of branches per vine varied from 2.18 to 3.60, 2.33 to 3.66 and 3.17 to 5.67 with over all mean performance of 2.82, 10.41 and 4.72 at 15, 30 and 45 DAS respectively. Genotype SG103 was recorded the highest number of branches 3.60, 3.66 and 5.67, while the genotype Vidhya172 proved to be lowest number of branches recording 2.18, 2.33 and 3.17 among all the genotypes studied at 15, 30 and 45 DAS respectively.

4.2.4 Days to first staminate and pistillate flowering in sponge gourd

Days to first staminate and pistillate flowering per vine was ranged 22.00 to 26.20, 24.40 to 28.00 respectively. The genotypes NS441recorded maximum days to first staminate flowering 26.20 and Kashi Divya recorded pistillate flowering 28.00, whereas the genotype VRSG2/13 recorded minimum days to first staminate flowering 22.00 and genotype Priya pistillate flowering 24.40. The average days to first appearances of staminate and pistillate flower per vine 24.24 and 26.46 respectively.

Table 4.2b: Mean performance of phenological parameters of sponge gourd

Genotypes	Days to first flowering		No. of nodes at which first flower appearances		Days to first harvest		No. of flower per vine		Sex ratio (staminate: pistillate)
	Staminate	Pistillate	Staminate	Pistillate	After sowing	After anthesis	Staminate	Pistillate	
Vasudha 175	24.33	25.00	1.11	6.33	34.12	7.67	333.33	42.73	7.80
Priya	23.33	24.40	3.11	9.16	33.11	7.13	326.66	46.00	7.10
SG101	24.66	25.60	1.65	7.40	35.14	8.41	330.13	44.01	7.50
SG102	24.33	25.20	2.26	9.29	34.22	8.21	356.66	46.92	7.60
VIDHYA172	23.66	25.40	4.21	8.43	35.17	8.13	341.90	42.49	8.05
SG103	25.33	27.80	1.29	8.81	37.66	9.37	452.66	56.66	7.99
SG104	25.00	27.67	2.15	6.75	36.80	9.14	370.33	49.37	7.50
VRSG8	23.66	26.61	1.58	8.58	36.70	7.97	424.27	48.21	8.80
VRSG2/13	22.00	26.00	1.33	5.54	32.66	8.13	470.56	56.69	8.30
VRSG2/14	24.00	27.17	2.37	5.32	33.16	8.69	409.33	49.31	8.30
VRSG68-1	23.33	25.83	1.26	6.20	32.12	7.47	423.00	56.40	7.50
VRSG140	24.33	27.42	1.37	5.99	33.20	8.13	383.27	50.43	7.60
VRSG182	23.99	27.40	1.31	4.66	34.00	8.43	429.66	48.43	8.94
NS441	26.20	27.45	1.35	6.05	35.43	9.37	415.13	54.62	7.60
KASHI DIVYA (C)	25.50	28.00	1.21	6.27	35.19	9.08	428.23	57.11	7.50
S.Em±	0.37	0.37	0.20	0.74	0.31	0.15	3.48	0.84	0.17
C.D.5% level	1.06	1.07	0.57	2.14	0.89	0.45	10.07	2.44	0.50

4.2.5 Number nodes at which first appearance of staminate and pistillate flowers in sponge gourd

Number of nodes at which first appearance of staminate and pistillate flowers was ranged 1.11 to 4.21 and 4.66 to 9.29 respectively. The genotypes Vidhya172 recorded maximum node at which first appearance of staminate flowering 4.21 and genotype SG102 recorded maximum node at which first appearance of pistillate flowers 9.29, whereas the genotype Vasudha175 recorded minimum node at which first appearance of staminate flowering 1.11 and genotype VRSG182 minimum node at which first appearance of pistillate flowering 4.66. The average number of nodes at which first appearance of staminate and pistillate flower 1.83 and 6.98 respectively.

4.2.6 Days to first harvesting in sponge gourd

Range for the days to first harvesting after sowing and anthesis between 32.12 to 37.66 and 7.13 to 9.37 respectively. The genotypes SG103 recorded maximum days to first harvest after sowing and anthesis between 37.66 and 9.37 respectively, where as the genotype VRSG68-1 recorded minimum days to first harvest after sowing 32.12 and genotype Priya recorded minimum days to first harvest after anthesis (7.13).

4.2.7 Number of flower per vine

Number of staminate and pistillate flowers per vine ranges between 326.66 to 470.56 and 42.49 to 57.11 with average range for the number of staminate and pistillate flower per vine was 393.00 and 49.95 respectively.. The genotypes VRSG2/13 recorded maximum number of staminate flowers 470.56 and the genotypes Kashi Divya recorded maximum number of pistillate flowers 57.11, where as the genotype Priya recorded minimum staminate flowers 326.66 and the genotype Vidhya172 recorded minimum number of pistillate flowers 42.49.

4.2.8 Sex ratio

Range for the sex ratio is 7.10 to 8.94. The genotypes VRSG182 recorded maximum sex ratio 8.94 where as the genotype Priya recorded minimum sex ratio 7.10.The average sex ratio was 8.46.

Table 4.2c: Mean performance of physiological parameters of sponge gourd

Genotypes	Chlorophyll content index (CCI) SPAD			Relative water content (RWC %)	
	15 DAS	30 DAS	45DAS	30 DAS	45DAS
Vasudha 175	46.17	76.43	80.80	80.11	82.39
Priya	43.13	58.40	64.10	72.61	75.59
SG101	48.03	60.10	64.30	70.56	72.81
SG102	64.03	79.13	86.00	80.15	84.92
VIDHYA172	50.47	65.63	71.53	76.39	86.85
SG103	55.50	74.33	77.93	81.28	84.79
SG104	57.03	67.43	74.73	83.06	84.47
VRSG8	63.30	72.93	77.67	86.31	86.90
VRSG2/13	53.13	67.10	78.93	76.07	86.31
VRSG2/14	57.80	70.90	76.03	80.95	80.95
VRSG68-1	53.17	67.47	73.17	84.92	84.92
VRSG140	50.47	73.07	80.97	79.26	81.11
VRSG182	52.00	60.83	74.50	84.12	86.11
NS441	46.13	70.47	76.07	82.87	86.31
KASHI DIVYA (C)	46.77	75.57	81.33	76.31	81.92
S.Em±	3.11	1.32	2.68	1.36	1.83
C.D.5% level	9.00	3.83	7.76	3.95	5.31

4.2.9 Chlorophyll content index (CCI)

Chlorophyll content index varied from 43.13 to 64.03, 58.40 to 79.13 and 64.10 to 86.00 with over all mean performance of 52.47, 69.31 and 75.87 at 15, 30 and 45 DAS respectively. The genotypes SG102 recorded maximum Chlorophyll content index 64.03, 79.13 and 86.00 at 15, 30 and 45 DAS respectively, where as the genotype Priya recorded minimum chlorophyll content index 43.13, 58.40 and 64.10 at 15, 30 and 45 DAS respectively.

4.2.10 Relative water content (RWC%)

Relative water content ranges between 70.56 to 86.31 and 72.81 to 86.90 with the average relative water content index 90.61 and 83.09 at 30 and 45 DAS respectively. The genotypes VRSG8 recorded maximum Relative water content 86.31 and 86.90 at 30 and 45 DAS respectively, where as the genotype SG101 recorded minimum Relative water content 70.56 and 72.81 at 30 and 45 DAS respectively.

4.2.11 Fruit shape

A wide range of variation was observed for fruit shape (Table4.2e). Based on shape of fruit the genotypes were categorized into three categories i.e. long, oblong and cylindrical. Most of the genotypes were found in long fruit shape while genotypes VRSG 68-1 and Kashi Divya exhibited oblong fruit shape. Only genotype SG102 exhibited cylindrical fruit shape.

4.2.12 Fruits skin colour

A wide range of variation was observed for fruit skin colour (Table4.2e). Based on fruit skin colour the genotypes were categorized into three categories i.e. light green, green and dark green. Most of the genotypes were found in dark green colour while genotypes VASUDHA 175, PRIYA, SG101, VRSG 2/14 and VRSG 182 exhibited light green colour. Only genotype SG103 exhibited green colour.

4.2.13 Fruit strip colour

For fruit strip colour character following data was recorded most of the genotypes were green while four genotypes (VIDHYA 172, VRSG2/14, VRSG68-1 and KASHI DIVYA) were dark green and only genotype (VASUDHA 175) was white green.

4.2.14 Fruit bitterness

A wide range of variability was observed for fruit bitterness for fruit bitterness *viz,* absent, low, medium and high. Fruit bitterness was found absent in maximum genotypes. However; it was found low in only three genotypes *viz*, PRIYA, VIDHYA 172, VRSG 2/13 and NS441.

4.2.15 Fruit skin texture

A wide range of variation was observed for fruit skin texture (Table4.2e). Based on fruit skin texture the genotypes were categorized into three categories i.e. strip, non-strip and spotted. Most of the genotypes were found in stripped, while genotypes, VRSG 2/14, VRSG 68-1 and VRSG 182 exhibited both stripped and spotted skin texture.

4.2.16 Vine growth habit

A wide range of variability was recorded for vine growth habit (Table4.2e). Based on vine growth habit the genotypes were categorized into three categories i.e. short, medium and long. Most of the genotypes recorded medium vine growth habit. Only two genotypes (SG103 and VRSG 2/13) recorded long vine growth habit.

4.2.17 Number of fruits per vine

Number of fruits per vine all the fifteen genotypes were in the ranged from 19.53 to 35.06. The genotype VRSG2/13 produced maximum number of fruits per vine 35.06, whereas the genotype SG104 produced minimum number of fruits 19.53. The average number of fruits per vine was 29.33

4.2.18 Fruits length (cm)

Length of fruit was ranged from 19.70 to 35.60 cm. The genotype VRSG2/13 recorded maximum fruit length 35.60 cm, whereas the genotype Kashi Divya recorded minimum fruit length 19.70 cm. The average fruit length was 24.36 cm.

4.2.19 Fruit girth (cm)

Girth of fruit was ranged from 2.25 to 3.11 cm. The genotype Vidhya172 recorded maximum girth of fruit 3.11 cm, whereas the genotype VRSG182 recorded minimum fruit girth 2.25 cm. The average girth of fruit was found to be 2.67 cm.

4.2.20 Average fruit weight (g)

The character average fruit weight for all the fifteen genotypes were ranged from 63.33gm to 122.22gm. The genotype VRSG2/13 possessed maximum fruit weight 122.22gm, whereas, the genotype SG102 had minimum fruit weight 63.33 gm. The mean weight of fruit was 96.57 gm.

4.2d: Performance of fruit character of sponge gourd.

Table 4.2d: Performance of fruit character of sponge gourd.

Parameters	Fruit shape	Fruit skin colour	Fruit strip colour	Fruit bitterness	Fruit skin texture	Vine growth habit
VASUDHA 175	Long	Light green	White green	Absent	Strip	Medium
PRIYA	Long	Light green	Green	Low	Strip	Medium
SG101	Long	Light green	Green	Absent	Strip	Medium
SG102	Cylindrical	Dark green	Green	Absent	Strip	Medium
VIDHYA 172	Long	Dark green	Dark green	Low	Strip	Medium
SG103	Long	Green	Green	Absent	Strip	Long
SG104	Long	Dark green	Green	Absent	Strip	Medium
VRSG 8	Long	Dark green	Green	Absent	Strip	Medium
VRSG 2/13	Long	Dark green	Green	Low	Strip	Long
VRSG 2/14	Long	Light green	Dark green	Absent	Strip and spotted	Medium
VRSG 68-1	Oblong	Dark green	Dark green	Absent	Strip and spotted	Medium
VRSG 140	Long	Dark green	Green	Absent	Strip	Medium
VRSG 182	Long	Light green	Green	Absent	Strip and spotted	Medium
NS441	Long	Dark green	Green	Low	Strip	Medium
KASHI DIVYA	Oblong	Dark green	Dark green	Absent	Strip	Medium

4.2.21 Fruit set (%)

The character fruit set percentage for all the fifteen genotypes were ranged from 63.63 to 84.42. The genotype VRSG2/13 possessed maximum fruit set percentage 84.42, whereas, the genotype SG104 had minimum fruit set percentage 63.63. The mean of fruit set percentage was 73.72.

4.2.22 Fruit yield (kg) per vine

The character fruit yield per vine for all the fifteen genotypes were ranged from 1.81 to 3.14kg. The genotype VRSG2/13 possessed maximum fruit yield per vine 3.14kg, whereas, the genotype SG104 had minimum fruit yield per vine 1.81kg. The mean of fruit yield per vine was 2.42kg.

4.2.23 Fruit yield (kg) per plot

The character fruit yield per plot for all the fifteen genotypes were ranged from 18.60 to 33.06kg. The genotype VRSG2/13 possessed maximum fruit yield per plot 33.06kg, whereas, the genotype SG104 had minimum fruit yield per plot 18.60kg. The mean of fruit yield per plot was 25.39kg.

4.2.24 Fruit yield (q) per hectare

The character fruit yield per hectare for all the fifteen genotypes were ranged from 165.94 to 294.90kg. The genotype VRSG2/13 possessed maximum fruit yield per hectare 294.90kg, whereas, the genotype SG104 had minimum fruit yield per hectare 165.94kg. The mean of fruit yield per hectare was 226.50kg.

4.3 Genetic variability

Estimation of component of genetic parameters of variation for fruit yield and its attributes exhibited a wide range for the characters studied (Table 4.3), result indicating that the values of phenotypic variance and phenotypic coefficient of variations were of higher magnitude than that of genotypic variance and genotypic variations for all the characters showing that the environment had an important role in influencing the expressions of the characters.

Table 4.2e: Mean performance of yield characters of sponge gourd

Genotypes	Number of fruits/vine	Fruit length (cm)	Fruit girth (cm)	Av. weight of fruit (g)	Fruit set (%)	Fruit yield /vine (kg)	Fruit yield /plot (kg)	Fruit yield /ha (q)
Vasudha 175	30.76	24.40	2.50	102.94	72.30	2.65	27.60	246.19
Priya	23.56	21.48	2.41	111.18	68.22	2.00	21.80	194.46
SG101	29.33	22.49	2.49	83.33	67.63	1.87	21.36	190.53
SG102	26.52	23.40	2.47	63.33	69.77	1.95	23.53	209.89
VIDHYA172	27.40	24.46	3.11	100.00	73.08	2.14	20.24	180.54
SG103	31.56	25.48	2.86	107.14	81.38	2.32	25.39	226.48
SG104	19.53	22.27	2.63	91.66	63.63	1.81	18.60	165.94
VRSG8	25.20	29.38	2.55	88.33	83.09	1.95	24.90	222.11
VRSG2/13	35.06	35.60	2.97	122.22	84.42	3.14	33.06	294.90
VRSG2/14	28.93	25.68	2.85	94.44	75.89	2.88	30.10	268.49
VRSG68-1	32.73	21.35	2.99	95.23	74.40	2.74	27.80	247.98
VRSG140	34.40	23.45	2.87	81.67	74.68	2.81	27.93	249.14
VRSG182	33.36	24.03	2.25	113.63	75.41	3.00	27.96	249.40
NS441	31.20	22.24	2.29	84.78	71.08	2.62	27.56	245.84
KASHI DIVYA (C)	30.53	19.70	2.82	108.79	70.85	2.54	23.06	205.70
S.Em±	1.37	1.36	0.02	5.00	2.76	0.17	0.61	5.40
C.D.5% level	3.97	3.94	0.06	14.48	8.00	0.48	1.75	15.65

4.3.1 Phenotypic coefficient of variation

The phenotypic coefficient of variation studied ranged from 4.76 % to 49.41 % for the various characters studied (Table 4.3).

Phenotypic coefficient of variation was recorded for the character number of nodes at which first appearance of staminate flower (49.41%), vine length (29.98%) at 15 DAS, number of nodes at which first appearance of pistillate flower (26.27%), number of leaves per vine (26.09%) at 15 DAS, fruit yield per vine (20.82%), fruit length (17.68%), average fruit weight (17.32%), number of fruit per vine (16.01%), fruit yield per plot (15.98%), fruit yield per hectare (15.98%), number of branches (15.92%) at 15 DAS and number of branches (15.70%) at 45 DAS, vine length (13.04%) at 30 DAS, number of branches per vine (12.09%) at 30 DAS, number of staminate flower per vine (12.09%), vine length (11.91%) at 45 DAS, number of pistillate flower per vine (10.69%), fruit girth (10.18%), fruit set percentage (9.49%), days to first harvest after anthesis (8.50%), number of leaves per vine (8.14%) at 45 DAS, days to first pistillate flowering (7.86%), sex ratio (7.29%), days to first harvest after sowing (4.87%) and days to first staminate flowering (4.76%).

4.3.2 Genotypic coefficient of variation

The data presented Table 4.3 revealed that the genotypic coefficient of variation (GCV) ranged from 3.97% to 45.81% for different characters under study.

Genotypic coefficient of variation was observed for number of nodes at which first appearance of staminate flower (45.81%), vine length (28.92%) at 15 DAS, number of leaves per vine (21.97%) at 15 DAS, number of nodes at which first appearance of pistillate flower (18.85%), fruit yield per vine (17.12%), number of branches per vine (15.46%) at 45 DAS, fruit yield per plot (15.44%), fruit yield per hectare (15.44%) and number of branches per vine (15.13%) at 15 DAS, average fruit weight (14.81%), fruit length (14.80%), number of fruit per vine (13.82%), number of leaves per vine (13.74%) at 45 DAS, number of staminate flower per vine (11.99%), vine length (10.92%) at 30 DAS, vine length (10.76%) at 45

DAS, number of pistillate flower per vine (10.28%), fruit length (10.08%), number of branches per vine (9.84%) at 30 DAS, days to first harvest after anthesis (7.88%), number of leaves per vine at 45 DAS (7.58%), fruit set percentage (6.93%), sex ratio (6.24%) and days to first pistillate flowering (4.22%).

4.3.3 Heritability and genetic advance

4.3.3.1 Heritability estimates in broad sense

The heritability estimates >90, 70-90 and 50-70 percent were classified as high, moderate and low respectively. High differences in the large environmental influence and consequently the lower estimates of heritability. Results presented in the Table 4.3 revealed that the heritability estimates in broad sense were of higher magnitude and ranged from 51.47 percent to 98.39 percent for the different characters studied.

These heritability values in that order were for number of staminate flower per vine (98.39%), fruit girth (98.08%), number of branches per vine (96.91%) at 45 DAS, fruit yield per plot (93.32%), fruit yield per hectare (93.31%), vine length (93.03%) at 15 DAS, number of pistillate flower per vine (92.50%), number of branches per vine (90.40%) at 15 DAS, days to first harvest after sowing (90.13%), while moderate values ware recorded in the number of leaves per vine (86.63%) at 45 DAS, number of nodes at which first appearance of staminate flower (85.96%), days to first harvest after anthesis (85.91%), vine length (81.62%) at 45 DAS, number of leaves per vine (78.93%) at 45 DAS, days to first pistillate flowering (75.43%), number of fruits per vine (74.52%), sex ratio (73.33%), average fruit weight (73.18%), number of leaves per vine (70.89%) at 15 DAS, fruit length (70.12%) and vine length (70.06%) at 30 DAS.

Low value of heritability was observed for the character of days to first staminate flowering (69.56%), fruit yield per vine (67.65%), number of branches per vine (66.20%) at 30 DAS, fruit set percentage (53.30%) and number of nodes at which first appearance of pistillate flower (51.47%).

Table 4.3: Genetic parameters in sponge gourd

Characters		Grand Mean	Range		Coefficient of variations		Heritability % (BS)	Genetic Advance	GA as % of mean
			Min.	Max.	Phenotypic	Genotypic			
Vine length (cm)	15 DAS	104.05	63.38	162.44	29.98	28.92	93.03	59.80	57.47
	30 DAS	257.42	201.73	305.80	13.04	10.92	70.06	48.47	18.83
	45DAS	335.58	226.55	382.47	11.91	10.76	81.62	67.21	20.03
No. of leaves / vine	15 DAS	13.92	10.03	21.60	26.09	21.97	70.89	5.30	38.10
	30 DAS	45.03	35.26	56.20	15.47	13.74	78.93	11.33	25.16
	45DAS	76.69	66.03	84.08	8.14	7.58	86.63	11.15	14.53
No. of branches /vine	15 DAS	2.83	2.18	3.60	15.92	15.13	90.40	0.84	29.61
	30 DAS	3.16	2.33	3.66	12.09	9.84	66.20	0.52	16.52
	45DAS	4.72	3.17	5.67	15.70	15.46	96.91	1.48	31.39
Days to first flowering	Staminate	24.24	22.00	26.20	4.76	3.97	69.56	1.65	6.82
	Pistillate	26.46	24.40	28.00	7.86	4.22	75.43	2.00	7.56
No. of nodes at which first flower appearances	Staminate	1.84	1.11	4.21	49.41	45.81	85.96	1.61	87.38
	Pistillate	6.99	4.66	9.29	26.27	18.85	51.47	1.95	27.85
Days to first harvest	After sowing	34.58	32.12	37.66	4.87	4.63	90.13	3.13	9.05
	After anthesis	8.36	7.13	9.37	8.50	7.88	85.91	1.26	15.03
No. of flower per vine	Staminate	393.01	326.66	470.56	12.09	11.99	98.39	96.28	24.50
	Pistillate	49.96	42.49	57.11	10.69	10.28	92.50	10.18	20.37
Sex ratio (male: female)		7.87	7.10	8.94	7.29	6.24	73.33	0.87	11.01
Number of fruits/vine		29.34	19.53	35.06	16.01	13.82	74.52	7.21	24.58
Fruit length (cm)		24.36	19.70	35.60	17.68	14.80	70.12	6.22	25.54
Fruit girth (cm)		2.67	2.25	3.11	10.18	10.08	98.08	0.55	20.57
Av. weight of fruit (g)		96.58	63.33	122.22	17.32	14.81	73.18	25.21	26.10
Fruit set (%)		73.72	63.63	84.42	9.49	6.93	53.30	7.69	10.43
Fruit yield /vine (kg)		2.43	1.81	3.14	20.82	17.12	67.65	0.70	28.98
Fruit yield /plot (kg)		25.39	18.60	33.06	15.98	15.44	93.32	7.80	30.73
Fruit yield /ha (q)		226.51	165.94	294.90	15.98	15.44	93.31	69.59	30.72

4.3.3.2 Genetic advance

The genetic advance was categorized as high (>50 percent), moderate (25-50 percent) and low (<25 percent). Genetic advance over mean was estimated for different characters and results are presented in Table 4.3. The results indicated that the expected genetic advance over mean observed was in the range of 6.82% to 87.38% for different characters.

The highest percent of genetic advance was noted for the character number of nodes at which first appearance of staminate flower (87.38%) followed by vine length (57.47%) at 15 DAS, while moderate values ware recorded in the number of leaves per vine (38.10%) at 15 DAS, number of branches per vine (31.39%) at 45 DAS, fruit yield per plot (30.73%), fruit yield per hectare (30.72%), number of branches per vine (29.61%) at 15 DAS, fruit yield per vine (28.98%), number of nodes first appearance of pistillate flower (27.85%), average fruit weight (26.10%), fruit length (25.54%) and number of leaves per vine (25.16%) at 30 DAS.

Low value of genetic advance were observed for the characters number of fruit per vine (24.58%), number of staminate flower per vine (24.50%), fruit girth (20.57%), number of pistillate flower per vine (20.37%), vine length (20.03%) at 30 DAS, vine length (18.83%) at 30 DAS, number of branches per vine (16.52%) at 30 DAS, days to first harvest after anthesis (15.03%), number of leaves per vine (14.53%) at 45 DAS, sex ratio (11.01%), fruit set percentage (10.43%), days to first harvest after sowing (9.05%), days to first pistillate flowering (7.56%) and days to first staminate flowering (6.82%).

High heritability coupled with high genetic advance as percentage of mean for traits like number of nodes at which first appearance of staminate flower followed by vine length at 15 DAS. Suggested that the preponderance of additive genes. It also indicated higher response for selection of high yielding genotypes as these characters are governed by additive gene actions.

High heritability supplemented with moderate genetic advances as percentage of mean was manifested by number of branches per vine at 45 DAS followed by fruit yield per plot, fruit yield per hectare and number of branches per vine at 15 DAS. This might be attributed to additive gene action conditioning their expression and phenotypic selection for their amenability can be brought about.

High heritability coupled with low genetic advance as percentage of mean was observed for days to first harvest after sowing, number of staminate flowers per vine and fruit girth. This revealed the predominance of non-additive gene action in the expression of these characters.

Low estimates of heritability coupled with low genetic advances as percentage of mean were displayed by number of branches per vine at 30 DAS and days to first staminate flowering that indicated that this character was highly influenced by environmental effects and consequently its selection would be ineffective.

4.4 Correlation studies

Correlation coefficient was worked out at phenotypic, genotypic and environmental levels for all possible combination of twelve yield and its attributing characters (Table 4.4). Results indicated that genotypic correlation coefficient, in general, were of higher magnitude than the corresponding phenotypic correlation coefficient for all the characters.

The results of phenotypic correlation coefficients have been discussed only as the genotypic and environmental correlation were mostly influenced by the environmental conditions, hence phenotypic correlation will give the correct idea about the association between two variables.

A) Vine length (cm)

Vine length at 45 DAS recorded highly significant and negative association with days to first harvest after sowing (-0.484), days to first appearance of staminate flower (-0.359) and number of node at witch first appearance of pistillate flower (-0.344).

B) Number of leaves per vine

Number of leaves per vine at 45 DAS showed positive and significant correlation with number of branches per vine (0.605) at 45 DAS, fruit set percentage (0.499), days to first pistillate flowering (0.389), sex ratio (0.380) and fruit length (0.375). However, negative and significant correlation was exhibited by number of nodes at which first appearance of staminate flower (-0.429).

C) Number of branches per vine

Number of branches per vine at 45 DAS showed positive and significant correlation with fruit set percentage (0.555), fruit yield per vine (0.446), days to first pistillate flowering (0.398), sex ratio (0.357) and fruit length (0.339). However, negative and significant correlations were found in number of nodes at which first appearance of staminate flower (-0.645) and number of nodes at which first appearance of pistillate flower (-0.389).

D) Days to first staminate flowering

Days to first staminate flowering showed positive and significant phenotypic correlation coefficient with days to first harvest after sowing (0.527) and days to first pistillate flowering (0.468). However, negative and significant correlation was noted with fruit length (-0.468).

E) Days to first pistillate flowering

Days to first pistillate flower showed positive and significant correlation with fruit set percentage (0.398) and days to first harvest after sowing (0372). However, negative and significant correlations were noted with number of nodes at which first appearance of staminate flower (0.369) and number of nodes at which first appearance of pistillate flower (-0.322).

F) Number of nodes at which first appearance of staminate flower

Number of nodes at which first appearance of staminate flower showed positive and significant correlation with number of nodes at which first appearance of pistillate flower (0.404). However negative and significant correlations were noted with number of fruits per vine (-0.419), fruit set percentage (-0.416) and fruit yield per vine (-0.374).

Table 4.4: Estimates of genotypic and phenotypic correlation coefficients among fruit yield and its attributing traits in sponge gourd

Characters		Leaves / vine 45DAS	Branches /vine 45DAS	Days to1st staminate flowering	Days to 1st pistillate flowering	No. of nodes to 1st staminate flower appearances	No. of nodes to 1st pistillate flower appearances	Days to 1st harvest After sowing	Sex ratio (staminate: pistillate)	No. of fruits /vine	Fruit length (cm)	Fruit girth (cm)	Av. fruit weight (g)	Fruit set (%)	Fruit yield/ vine (Kg)
Vine length (cm) 45DAS	G	0.320	0.140	-0.405	-0.053	0.048	-0.657	-0.592	-0.088	0.066	0.068	0.020	-0.127	-0.288	0.302
	P	0.281	0.133	-0.359*	-0.008	0.033	-0.344*	-0.484**	-0.102	-0.029	0.047	0.028	-0.105	-0.141	0.239
No. of leaves / vine45DAS	G	1	0.626	-0.269	0.509	-0.478	-0.519	-0.170	0.447	0.281	0.449	-0.060	-0.157	0.784	0.405
	P		0.605**	-0.197	0.389**	-0.429**	-0.281	-0.102	0.380**	0.194	0.375*	-0.054	-0.114	0.499**	0.377*
No.branches /vine45DAS	G		1	-0.233	0.479	-0.697	-0.585	-0.123	0.436	0.199	0.400	0.018	0.336	0.819	0.507
	P			-0.157	0.398**	-0.645**	-0.389**	-0.105	0.357*	0.178	0.339*	0.011	0.270	0.555**	0.446**
Days to 1st staminate flowering	G			1	0.608	-0.277	0.044	0.663	-0.358	0.259	-0.726	-0.056	-0.289	-0.205	-0.269
	P				0.468**	-0.179	-0.001	0.527**	-0.234	0.267	-0.468**	-0.065	-0.284	-0.118	-0.141
Days to 1st pistillate flowering	G				1	-0.484	-0.550	0.464	0.291	0.400	-0.055	-0.036	0.105	0.481	0.329
	P					-0.369*	-0.322*	0.372*	0.217	0.280	-0.094	-0.017	0.100	0.398**	0.254
No. of nodes to 1st staminate flower appearances	G					1	0.565	0.002	-0.142	-0.533	-0.100	0.179	-0.081	-0.694	-0.479
	P						0.404**	-0.022	-0.105	-0.419**	-0.105	0.175	-0.044	-0.416**	-0.374*
No. of nodes to 1st pistillate flower appearances	G						1	0.479	-0.293	-0.779	-0.196	0.043	-0.499	-0.202	-1.118
	P							0.345*	-0.271	-0.493**	0.028	0.038	-0.119	-0.091	-0.502**
Days to 1st harvest After sowing	G							1	0.125	-0.354	-0.073	-0.048	-0.102	0.247	-0.639
	P								0.115	-0.245	-0.067	-0.039	-0.115	0.139	-0.481**
Sex ratio (male: female)	G								1	-0.066	0.724	-0.151	0.356	0.694	0.356
	P									-0.082	0.474**	-0.115	0.265	0.373*	0.225
No. of fruits /vine	G									1	-0.154	0.096	0.200	0.035	0.846
	P										-0.120	0.075	0.084	-0.020	0.620**
Fruit length (cm)	G										1	-0.111	0.205	0.770	0.239
	P											-0.100	0.188	0.444**	0.324*
Fruit girth (cm)	G											1	0.015	-0.075	0.108
	P												0.011	-0.035	0.073
Av. fruit weight (g)	G												1	0.248	0.487
	P													0.198	0.392**
Fruit set (%)	G													1	0.394
	P														0.176

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

G) Number of nodes at which first appearance of pistillate flower

Number of nodes at which first appearance of pistillate flower showed positive and significant correlation with days to first harvest after sowing (0.345). However negative and significant correlations were noted with fruit yield vine (-0.502) and number of fruit per vine (-0.493).

H) Days to first harvest after sowing

Days to first harvest after sowing showed negative and significant correlation with fruit yield per vine (-0.481)

I) Sex ratio

Sex ratio showed positive and significant correlation with fruit length (0.474) and fruit set percentage (0.373).

J) Number of fruits per vine

Number of fruit per vine showed positive and significant correlation with fruit yield per vine (0.620).

K) Fruit length (cm)

Fruit length showed positive and significant correlation with fruit set percentage (0.444) and fruit yield per vine (0.324).

L) Average fruit weight (g)

Average fruit weight showed positive and significant correlation with fruit yield per vine (0.392).

M) Fruit yield (kg) per vine

Fruit yield per vine showed highly significant and positive correlation with number of leaves per vine at 45 DAS, number of branches per vine, number of fruits per vine, fruit length and average fruit weight. However, negative and significant correlations were noted with number of nodes at which first staminate flower (-0.374), number of nodes at which pistillate flower (-0.502) and days to first harvesting after sowing (-0.481).

4.5 Path coefficient analysis

To measure the direct as well as indirect association of one variable (cause) through another on the end product (effect). Path coefficient was calculated at genotypic and phenotypic level for all the yield attributing traits. The observed correlation coefficients of fruit yield with its contributing traits were partitioned into direct and indirect effects. In the present investigation, important characters viz., fruit yield per vine was used as dependent variable. Since the value of genotypic path is more reliable in predicting the correct idea about the direct and indirect effect of the component traits, only this has been discussed below.

The estimates of path coefficient are furnished in the Table 4.4. In general, the genotypic direct as well as indirect effects were slightly higher in magnitude as compared to corresponding phenotypic direct and indirect effects are presented as under.

4.5.1 Direct effect

Path coefficient analysis of different characters contributing towards days to first harvest after sowing (22.394) had highest positive direct effect followed by number of fruits per vine (17.007), days to first pistillate flowering (15.665), number of branches per vine (12.940) at 45 DAS, vine length (5.723) at 45 DAS, number of nodes at which first appearance of staminate flower (5.052), number of leaves per vine (4.750) at 45 DAS, sex ratio (3.215) and number of nodes at which first appearance of pistillate flower (2.349). Whereas, days to first staminate flowering (-7.261) had the highest negative direct effect on fruit yield per vine followed by fruit length (-6.585), fruit set percentage (-5.590), fruit girth (-3.141) and average fruit weight (-0.740) had negative direct effect.

4.5.2 Indirect effect

4.5.2.1 Vine length (cm)

Vine length at 45 DAS imparted highest positive indirect effect on fruit yield per vine via days to first harvest after sowing (13.247) followed by days to first staminate flowering (2.942), number of branches per vine at 45 DAS (1.806), fruit set percentage (1.612), number of leaves per vine at 45 DAS

(1.522), number of fruits per vine (1.121), days to first pistillate flowering (0.825) and average fruit weight (0.094). However, indirect effect was negative via number of nodes at which first appearance of pistillate flower (-1.544), fruit length (-0.447), sex ratio (-0.282) and fruit girth (-0.064).

4.5.2.2 Number of leaves per vine

Number of leaves per vine at 45 DAS was recorded to have positive indirect effect on fruit yield per vine through number of branches per vine at 45 DAS (8.098) followed by number of fruit per vine (4.783), days to first staminate flowering (1.950), vine length (1.834) at 45 DAS, sex ratio (1.436), fruit girth (0.189) and average fruit weight (0.116). However, negative indirect effect was expressed via days to first pistillate flowering (-7.971), fruit set percentage (-4.381), days to first harvest after sowing (-3.809), fruit length (-2.959), number of nodes at which appearance of staminate flower (-2.413) and number of nodes at which first appearance of pistillate flower (-1.218).

4.5.2.3 Number of branches per vine

Number of branches at 45 DAS was recorded to have positive indirect effect on fruit yield per vine via number fruits per vine (3.392) followed by number of leaves per vine (2.973) at 45 DAS, days to first staminate flowering (1.689), sex ratio (1.400) and vine length (0.799) at 45 DAS. However, negative indirect effect was expressed via days to first pistillate flowering (-7.507), fruit set percentage (-4.579) number of nodes at which first appearance of staminate flower (-3.522), days to first harvest after sowing (-2.763), fruit length (-2.637), number of nodes at which first appearance of pistillate flower (-1.375), average fruit weight (-0.249) and fruit girth (-0.055).

4.5.2.4 Days to first staminate flowering

Days to first harvest after sowing (14.843) revealed high positive indirect effect on fruit yield per vine followed by fruit length (4.782), fruit set percentage (1.146), average fruit weight (0.214), fruit girth (0.175) and number of nodes at which first appearance of pistillate flower (0.102). However, negative indirect effect was expressed via days to first pistillate flowering (-9.527), number of branches per vine (-3.009) at 45 DAS, vine length (-2.319) at 45 DAS, number of leaves per vine (-1.276) at 45 DAS and number of nodes at which first appearance of pistillate flower (-1.401).

4.5.2.5 Days to first pistillate flowering

Days to first harvest after sowing (10.390) revealed high positive indirect effect on fruit yield per vine followed by number of fruits per vine (6.799), number of branches per vine (6.201) at 45 DAS, number of leaves per vine (2.417) at 45 DAS, sex ratio (0.935), fruit length (0.359) and fruit girth (0.114). However, negative indirect effect was expressed via days to first staminate flowering (-4.416), fruit set percentage (-2.689), number of nodes at which first appearance of staminate flower (-2.445), number of nodes at which first appearance of pistillate flower (-1.293), vine length (-0.301) at 45 DAS and average fruit weight (-0.077).

4.5.2.6 Number of nodes at which first appearances of staminate flower

Days to first pistillate flowering (7.582) revealed high positive indirect effect on fruit yield per vine followed by fruit set percentage (3.879), days to first staminate flowering (2.014), number of nodes at which first appearance of pistillate flower (1.327), fruit length (0.660), vine length (0.274) at 45 DAS, average fruit weight (0.060) and days to first harvest after sowing (0.049). However, negative indirect effect was expressed via number of fruits per vine (-9.067), number of branches per vine (-9.023) at 45 DAS, number of leaves per vine (-2.269) at 45 DAS, fruit girt (-0.562) and sex ratio (-0.456).

4.5.2.7 Number of nodes at which first appearances of pistillate flower

Number of fruits per vine (13.252) revealed high positive indirect effect on fruit yield per vine followed by days to first harvest after sowing (10.715), days to first pistillate flowering (8.621), number of nodes at which first appearance of staminate flower (2.854), fruit length (1.293), fruit set percentage (1.132) and average fruit weight (0.060). However, negative indirect effect was expressed via number of branches per vine (-7.575) at 45 DAS, vine length (-3.762) at 45 DAS, number of leaves per vine (-2.464) at 45 DAS, sex ratio (-0.943), days to first staminate flowering (-0.319) and fruit girth (-0.136).

4.5.2.8 Days to first harvest after sowing

Number of nodes at which first appearance of pistillate flower (1.125) revealed high positive indirect effect on fruit yield per vine followed by fruit length (0.482), sex ratio (0.402), fruit girth (0.151), average fruit weight (0.075) and number of nodes at which first appearance of staminate flower (0.010). However, negative indirect effect was expressed via days to first pistillate flowering (-7.269), number of fruits per vine (-6.0260, days to first staminate flowering (-4.814), vine length (-3.762) at 45 DAS, number of branches per vine (-1.596) at 45 DAS, fruit set percentage (-1.379) and number of leaves per vine (-0.808) at 45 DAS.

4.5.2.9 Sex ratio

Number of branches per vine (5.642) at 45 DAS revealed high positive indirect effect on fruit yield per vine followed by days to first harvest after sowing (2.799), days to first staminate flowering (2.597), number of leaves per vine (2.123) at 45 DAS and fruit girth (0.474). However, negative indirect effect was expressed via fruit length (-4.767), days to first pistillate flowering (-4.558), fruit set percentage (-3.879), number of fruit per vine (-1.118), number of nodes at which first appearance of staminate flower (-0.717), number of nodes at which first appearance of pistillate flower (-0.689) and vine length (-0.503) at 45 DAS.

4.5.2.10 Number of fruits per vine

Number of branches per vine (2.575) at 45 DAS revealed high positive indirect effect on fruit yield per vine followed by number of leaves per vine (1.335) at 45 DAS, fruit length (1.013) and vine length (0.377) at 45 DAS. However, negative indirect effect was expressed via days to first harvest after sowing (-7.934), days to first pistillate flowering (-6.266), number of nodes at which first appearance of staminate flower (-2.693), days to first staminate flowering (-1.881), number of nodes at which first appearance of pistillate flower (-1.830), fruit girth (-0.301), fruit set percentage (-0.198), sex ratio (-0.211) and average fruit weight (-0.148).

4.5.2.11 Fruit length (cm)

Days to first staminate flowering (5.273) revealed high positive indirect effect on fruit yield per vine followed by number of branches per vine (5.176) at 45 DAS, sex ratio (2.327), number of leaves per vine (2.133) at 45 DAS, days to first pistillate flowering (0.854), vine length (0.389) at 45 DAS and fruit girth (0.349). However, negative indirect effect was expressed via fruit set percentage (-4.302), number of fruit per vine (-2.615), days to first harvest first harvesting after sowing (-1.639), number of nodes at which first appearance of staminate flower (-0.506), number of nodes at which first appearance of pistillate flower (-0.461) and average fruit weight (-0.152).

4.5.2.12 Fruit girth (cm)

Number of fruits per vine (1.633) revealed high positive indirect effect on fruit yield per vine followed by number of nodes at which first appearances of staminate flower (0.904), fruit length (0.732), days to first pistillate flowering (0.568), days to first staminate flowering (0.404) number of branches per vine (0.233) vine length at 45 DAS (0.116), number of nodes at which first appearances of pistillate flower (0.101). However, negative indirect effect was expressed via days to first harvest after sowing (-1.079), sex ratio (-0.485), number of leaves per vine (-0.285) and average fruit weight (-0.011).

4.5.2.13 Average fruit weight (g)

Number of branches per vine (4.348) at 45 DAS revealed high positive indirect effect on fruit yield per vine followed by number of fruits per vine (3.401), days to first staminate flowering (2.097) and sex ratio (1.144). However, negative indirect effect was expressed via days to first harvest after sowing (-2.285), days to first pistillate flowering (-1.645), fruit set percentage (-1.384), fruit length (-1.350), number of nodes at which first appearance of pistillate flower (-1.171), number of leaves per vine (-0.745) at 45 DAS, vine length (-0.726) at 45 DAS, number of nodes at which first appearance of staminate flower (-0.411) and fruit girth (-0.047).

4.5.2.14 Fruit set (%)

Number of branches per vine (10.598) at 45 DAS revealed high positive indirect effect on fruit yield per vine followed by days to first harvest after sowing (5.531), number of leaves per vine (3.724) at 45 DAS, sex ratio (2.231), days to first staminate flowering (1.489), number of fruits per vine (90.595) and fruit girth (0.235). However, negative indirect effect was expressed via fruit length (-5.071), number of nodes at which first appearance of staminate flower (-3.505), days to first pistillate flowering (-3.493), number of nodes at which first appearance of pistillate flower (-0.476), vine length (-1.650) at 45 DAS and average fruit weight (-0.183).

Table 4.5a: Genotypic path coefficients showing direct and indirect effects of different characters on fruit yield per vine (g) in sponge gourd

Characters	Vine length (cm) 45DAS	Leaves / vine 45DAS	Branche s /vine 45DAS	Days to1^{st} staminate flowering	Days to 1^{st} pistillate flowering	No. of nodes to 1^{st} staminate flower appearances	No. of nodes to 1^{st} pistillate flower appearances	Days to 1^{st} harvest After sowing	Sex ratio (staminate: pistillate)	No. of fruits /vine	Fruit length (cm)	Fruit girth (cm)	Av. fruit weight (g)	Fruit set (%)	"r" value Fruit yield/ vine
Vine length (cm) 45DAS	**5.723**	1.522	1.806	2.942	0.825	0.242	-1.544	-13.247	-0.282	1.121	-0.447	-0.064	0.094	1.612	0.302
leaves / vine 45DAS	1.834	**4.750**	8.098	1.950	-7.971	-2.413	-1.218	-3.809	1.436	4.783	-2.959	0.189	0.116	-4.381	0.405
branches /vine 45DAS	0.799	2.973	**12.940**	1.689	-7.507	-3.522	-1.375	-2.763	1.400	3.392	-2.637	-0.055	-0.249	-4.579	0.507
Days to1^{st} staminate flowering	-2.319	-1.276	-3.009	**-7.261**	-9.527	-1.401	0.102	14.843	-1.150	4.412	4.782	0.175	0.214	1.146	-0.269
Days to 1^{st} pistillate flowering	-0.301	2.417	6.201	-4.416	**-15.665**	-2.445	-1.293	10.390	0.935	6.799	0.359	0.114	-0.077	-2.689	0.329
No. of nodes to 1^{st} staminate flower appearances	0.274	-2.269	-9.023	2.014	7.582	**5.052**	1.327	0.049	-0.456	-9.067	0.660	-0.562	0.060	3.879	-0.479
No. of nodes to 1^{st} pistillate flower appearances	-3.762	-2.464	-7.575	-0.319	8.621	2.854	**2.349**	10.715	-0.943	-13.252	1.293	-0.136	0.369	1.132	-1.118
Days to 1^{st} harvest After sowing	-3.385	-0.808	-1.596	-4.814	-7.269	0.010	1.125	**22.392**	0.402	-6.026	0.482	0.151	0.075	-1.379	-0.639
Sex ratio (male: female)	-0.503	2.123	5.642	2.597	-4.558	-0.717	-0.689	2.799	**3.215**	-1.118	-4.767	0.474	-0.263	-3.879	0.356
No. of fruits /vine	0.377	1.335	2.575	-1.881	-6.266	-2.693	-1.830	-7.934	-0.211	**17.007**	1.013	-0.301	-0.148	-0.198	0.846
Fruit length (cm)	0.389	2.133	5.176	5.273	0.854	-0.506	-0.461	-1.639	2.327	-2.615	**-6.585**	0.349	-0.152	-4.302	0.239
Fruit girth (cm)	0.116	-0.285	0.233	0.404	0.568	0.904	0.101	-1.079	-0.485	1.633	0.732	**-3.141**	-0.011	0.419	0.108
Av. fruit weight (g)	-0.726	-0.745	4.348	2.097	-1.645	-0.411	-1.171	-2.285	1.144	3.401	-1.350	-0.047	**-0.740**	-1.384	0.487
Fruit set (%)	-1.650	3.724	10.598	1.489	-3.493	-3.505	-0.476	5.531	2.231	0.595	-5.071	0.235	-0.183	**-5.590**	0.394

Residual effect Genotypic = 1.516

Table 4.5b: Phenotypic path coefficients showing direct and indirect effects of different characters on fruit yield per vine (g) in sponge gourd

Characters	Vine length (cm) 45DAS	Leaves / vine 45DAS	Branches /vine 45DAS	Days to1st staminate flowering	Days to 1st pistillate flowering	No. of nodes to 1st staminate flower appearances	No. of nodes to 1st pistillate flower appearances	Days to 1st harvest After sowing	Sex ratio (staminate: pistillate)	No. of fruits /vine	Fruit length (cm)	Fruit girth (cm)	Av. fruit weight (g)	Fruit set (%)	"r" value Fruit yield/ vine
Vine length (cm) 45DAS	**0.097**	0.026	-0.002	-0.080	-0.002	-0.004	-0.017	0.233	-0.011	-0.011	0.018	0.003	-0.032	0.020	0.239
leaves / vine 45DAS	0.027	**0.093**	-0.010	-0.044	0.082	0.052	-0.014	0.049	0.039	0.070	0.142	-0.006	-0.034	-0.070	0.377
branches /vine 45DAS	0.013	0.056	**-0.017**	-0.035	0.084	0.079	-0.019	0.050	0.037	0.065	0.128	0.001	0.082	-0.078	0.446
Days to1st staminate flowering	-0.035	-0.018	0.003	**0.224**	0.098	0.022	0.000	-0.253	-0.024	0.097	-0.177	-0.007	-0.086	0.017	-0.141
Days to 1st pistillate flowering	-0.001	0.036	-0.007	0.105	**0.210**	0.045	-0.016	-0.179	0.022	0.101	-0.036	-0.002	0.030	-0.056	0.254
No. of nodes to 1st staminate flower appearances	0.003	-0.040	0.011	-0.040	-0.077	**-0.122**	0.020	0.010	-0.011	-0.152	-0.040	0.019	-0.013	0.058	-0.374
No. of nodes to 1st pistillate flower appearances	-0.033	-0.026	0.006	0.000	-0.068	-0.049	**0.050**	-0.166	-0.028	-0.179	0.011	0.004	-0.036	0.013	-0.502
Days to 1st harvest After sowing	-0.047	-0.010	0.002	0.118	0.078	0.003	0.017	**-0.481**	0.012	-0.089	-0.025	-0.004	-0.035	-0.020	-0.481
Sex ratio (male: female)	-0.010	0.035	-0.006	-0.052	0.046	0.013	-0.013	-0.055	**0.103**	-0.030	0.179	-0.012	0.080	-0.052	0.225
No. of fruits /vine	-0.003	0.018	-0.003	0.060	0.059	0.051	-0.024	0.118	-0.008	**0.362**	-0.045	0.008	0.025	0.003	0.620
Fruit length (cm)	0.005	0.035	-0.006	-0.105	-0.020	0.013	0.001	0.032	0.049	-0.044	**0.379**	-0.011	0.057	-0.062	0.324
Fruit girth (cm)	0.003	-0.005	0.000	-0.015	-0.004	-0.021	0.002	0.019	-0.012	0.027	-0.038	**0.108**	0.003	0.005	0.073
Av. fruit weight (g)	-0.010	-0.011	-0.004	-0.063	0.021	0.005	-0.006	0.055	0.027	0.030	0.071	0.001	**0.302**	-0.028	0.392
Fruit set (%)	-0.014	0.047	-0.009	-0.026	0.084	0.051	-0.005	-0.067	0.038	-0.007	0.168	-0.013	0.060	**-0.141**	0.176

Residual effect Phenotypic = 0.4502

DISCUSSION

The experimental findings of the present investigation "Studies on Genetic Variability, character association and physiological analysis in sponge gourd *[Luffa cylindrical* (M) Roem.] have been discussed on the following heads in the light of the available literature.

5.1 Analysis of variance

5.2 Genetic variability

5.3 Correlation coefficient analysais

5.4 Path coefficient analysais

5.5 Chlorophyll content index (CCI)

5.6 Relative water content (RWC %)

In a crop improvement programme, the success of selection depends on the extent of genetic variability and correlation between the characters in the population or germplasm. The magnitude of genetic variability can determine the pace and quantum of genetic improvement through selection or through hybridization followed by selection. Phenotypic variance measures the magnitude of variation arising out of differences in the phenotypic values while the genotypic variance measures the magnitude of variation due to difference with the genotypic value. The genetic variability estimated in terms of genotypic coefficient of variation and phenotypic coefficients of variation are not adequate for the estimation of heritable variation. The heritability values, in broad sense are also helpful in selection on the basis of phenotypic performance of the quantitative characters. However, heritability estimates alone are not of any use in predicting the results of selection unless the correlation studies which indicate degree of relationship between yield and its components is done. Correlation studies provide information on nature, extent and direction of selection.

Considering these and the ultimate aim of exploiting all the possibilities for the improvement of the various characters studied, the results so obtained in the present investigation are discussed here under.

5.1 Analysis of variance

Analysis of variance for different characters under study revealed that the mean difference due to genotypes was highly significant for all the characters. The presence of such variability in the population under study is the ultimate result of variability in the genetic constitution of various individuals. Such variability is desirable and can be utilized for developing new genotypes in sponge gourd. The progress in breeding programme depends upon availability of genetic variability and understanding this variability provides many avenues for genetic improvement of crop without which neither the improvement in existing lines nor is development of new lines feasible. More the variability, higher is the chance of improvement of crop species. These results are in confirmation with Khule et al. (2011), Kumar et al. (2013) in sponge gourd, Koppad et al. (2015b) in ridge gourd, Narayanankutty et al. (2006) in snake gourd, Yadav and Kumar (2012) in bottle gourd.

5.2 Genetic Variability Studies

The data recorded with regard to mean and range revealed great variation in the genotypes for different parameters under study. Maximum range was recorded for number of staminate flower per vine followed by vine length (cm) at 45 DAS, vine length (cm) at 30 DAS, fruit yield per hactare (q) and average fruit weight (g) indicating more variability in these traits which indicate a greater scope for selection among the existing genotype, whereas, minimum range was recorded for fruit girth (cm) followed by sex ratio, days to first harvest after anthesis, days to first pistillate flowering and days to first staminate flowering etc. Kumar et al. (2013) in sponge gourd and Narayanankutty et al. (2006) in snake gourd also recorded maximum range for yield per vine (kg) followed by number of fruits per vine and average fruit weight (g).

5.2.1 Phenotypic coefficient of variation

Phenotypic coefficient of variation was higher than their corresponding genotypic of variation for all the characters. Phenotypic coefficient of variation was highest for number of nodes at which first staminate flower appearance followed by vine length (cm) at 15 DAS, number of nodes at which first pistillate flower appearance and number of leaves per vine at 15 DAS, whereas, it was exhibited low for vine length at 30 DAS, number of branches per vine at 30 DAS, number of staminate flower per vine, vine length at 45 DAS, number of pistillate flowers per vine, fruit girth, fruit set percentage, days to first harvest after anthesis, number of leaves per vine at 45 DAS, days to first appearance of pistillate flower per vine, sex ratio, days to first harvest after sowing, days to first appearance of staminate flower. Similar findings were recorded by Yadav and Kumar (2012) in bottle gourd and Koppad et al. (2015b) in ridge gourd.

5.2.2 Genotypic coefficient of variation

The high values of genotypic coefficient of variation were observed for number of nodes at which first appearance of staminate flower, vine length at 15 DAS, whereas, it was exhibited low value for days to first appearance of pistillate flower. Similar findings were recorded by Yadav and Kumar (2012) in bottle gourd.

With the genetic coefficient of variation alone, it is difficult to determine the relative amount of heritable and non-heritable components of variations present in the population. Estimates of heritability and genetic advance would supplement this parameter. The heritability (broad sense) ranged from 51.47 per cent (number of nodes at which first appearance of pistillate flower) to 98.39 per cent (number of staminate flower per vine). The higher estimates were observed for number of staminate flowers per vine (98.39%) followed by fruit girth (98.08%), number of branches per vine (96.91%), fruit yield per plot (93.32%) and fruit yield per hectare (93.31%), vine length (93.03%) at 15 DAS, number of pistillate flower per vine (92.50%), number of branches per vine (90.40%) and days to first harvest after sowing (90.13%) indicating less influence of environment on the expression of these characters. Moderate to low value of heritability was recorded for number of branches per vine (86.20%), number of nodes at which first appearance of staminate flower (85.96%), days to first harvest after anthesis (85.91%), vine length (81.62%) at 45 DAS and number of fruits per vine (74.52%) indicating relative influence of environment affecting the expression of these characters. Overall, these results indicate the presence of high heritability for all the characters. High heritability estimates suggest the major role of genetic constitution in the expression of the character and such traits are considered to be dependable from breeding point of view. Similar results were reported by Rajput et al. (1996), Islam et al. (2009), Dey et al. (2005), Emina et al. (2012), Yadav and Kumar (2012) and Kumar et al. (2013).

There was not much difference observed between GCV and PCV values in almost all the characters indicating less influence of environment. As per expectation, the magnitude of PVC was slightly higher than the GCV for all the characters. Higher values of genotypic as well as phenotypic coefficient of variation were observed for the characters viz., number of nodes at which first appearance of staminate flower, vine length at 15 DAS, number of leaves per vine at 15 DAS, number of nodes at which first appearance of pistillate flower, fruit yield per vine, number of branches per vine at 45 DAS, fruit yield per plot and fruit yield per hectare indicating predominance of additive gene action in the inheritance of these characters revealing likelihood of favorable response to selection by these characters. These results are in conformity with the findings of earlier workers like Dey et al. (2005) who studied 38 bitter gourd genotypes and observed a wide range of variation for all the 12 quantitative characters and reported high estimates of (GCV), (PCV) for characters like average fruit weight (g), average fruit diameter (cm), average flesh thickness (cm) and yield per vine (g). Rajput et al (1996) reported that PCV were higher than the GCV for seeds per fruit and yield per vine in bitter gourd. The high magnitude of GCV further revealed the great extent of variability present in these characters, thereby suggesting good scope for improvement through selection.

5.2.3 Heritability and genetic advance

Heritability estimates alone are not of any use in predicting the results about the selection unless it is accompanied by genetic advance *(*Johnson et al., 1955). The expected genetic advance (EGA) expressed as percentage over mean ranged from 6.82 percent (days to first appearance of staminate flower) to 87.38 percent (number of nodes at which first appearance of staminate flower). In the present study, high values of GA were observed for the character viz., number of nodes at which first appearance of staminate flower (87.38%) followed by the vine length (57.47%) at 15 DAS, while moderate values of EGA were recorded for the character number of leaves per vine at 15 DAS (38.10%) followed by number of branches per vine (31.39%) at 45 DAS, fruit yield per plot (30.73%), fruit yield per hectare (30.72%), number of branches per vine (29.61%), fruit yield per vine (28.98%), number of nodes at which first appearance of pistillate flower (27.85%), average fruit weight (26.10), fruit length (25.54%) and number of leaves per vine (25.16%) at 30 DAS.

These observations of high to moderate estimates of GA are indicative of the fact that improvement could be quickly released in these characters through selection. During the present investigation, low values of expected genetic advance were observed for the characters number of fruit per vine (24.58%), number of staminate flower per vine (24.50%), fruit girth (20.57%), number of pistillate flower per vine (20.37%), vine length (20.03%) at 45 DAS, vine length (18.83%) at 30 DAS, number of branches per vine (16.52%) at 30 DAS, days to first harvest after anthesis (15.03%), number of leaves per vine (14.53%) at 45 DAS, sex ratio (11.01%), fruit set percentage (10.43%), days to first harvest after sowing (9.05%), days to first appearance of pistillate flower (7.56%), days to first appearance of staminate flower (6.82%) indicating considerable influence of environment on the expression of all these characters. Similar findings with high GA have been reported by Husna et al. (2011) for the characters yield per plant and days of first staminate flowering, number of branches per vine, vine length, number of fruits per vine and yield per vine; Yadav et al. (2008) for fruit length, fruit width, days to first pistillate flowering, days to first staminate flowering and yield per vine and Singh et al. (2008) for average fruit weight, number of nodes at which first appearance of staminate flower, number of nodes at which first appearance of pistillate flower, fruit yield per vine and fruit length.

Generally higher heritability accompanied with high genetic advance in a character suggests that the inheritance of such character is governed mainly by additive gene effects and therefore, selection based on phenotypic performance may prove useful. It may be mentioned here that during present study characters like vine length at 15 DAS, number of nodes at which first appearance staminate flower had high heritability coupled with the high genetic advance. Thus, the expression of these traits is predominantly governed by additive gene effects and therefore, selection based on phenotypic performance will be helpful to improve these characters in future. Moreover, it is seen that these traits have less influence of the environment.

During present study estimates of high heritability along with low genetic advance were observed for the characters, days to first harvest after sowing, number of staminate flowers per vine, number of pistillate flower per vine and fruit girth.

5.3 Correlation

Yield is the result out of combined of several component character and environment. Understanding the interaction of characters among themselves and with environment has been of great use in the plant breeding.

Correlation studies provide information on the nature and extent of association between only two pairs of metric characters. From this, it would be possible to bring about genetic up gradation in our characters by selection of the other of a pair, obviously knowledge about character association will surely help to identity the character to make selection for higher yield with a view to determine the extent and nature of relationship prevailing among yield contributing characters.

The interrelationship between two characters can be directly observed by the phenotypic correlations. The genotypic correlations may be interpreted as the correlation of breeding value. When two characters are invariably and linearly associated, the under lined genetic mechanism causing such association may be due to complete linkage between the two traits or pleiotropy. Some gene may increase both the traits (Positive association). The present discussion is mostly concentrated on genotypic correlations because they provide an idea of association at genotypic level of inherent association between two traits and they help in carrying out reliable selection in situations where phenotypic and genotypic association is closer one.

In the present investigation, genotypic correlation are higher than the phenotypic correlation indicating less influence of environment and the presence of inherent association between various characters. Higher magnitude of genotypic correlation was observed earlier also by Srivastava and Srivastava (1976) and Dey et al. (2005) in bitter gourd, Bharthi et al. (2009) in spine gourd, Narayanankutty et al. (2006) and Padmaraja et al. (2014) in snake gourd.

The results revealed that fruit yield per vine showed positive and significant correlation with number of leaves per vine at 45 DAS, number of branches per vine at 45 DAS, number of fruits per vine, fruit length and average fruit weight. Whereas, negative association was exhibited by number of nodes at which first appearance of staminate flower, number of nodes at which first appearance of pistillate flower and days to first harvest after sowing. Padmaraja et al. (2014) and Ramachandran and Gopalkrishnan (1979) made similar observations in case of vine length at 45 DAS, number of fruits per vine, fruit length and average fruit weight.

The results obtained in the present study revealed that vine length exhibited negative and significant correlation with days to first staminate flowering, number of nodes at which first appearance of pistillate flower and days to first harvest after sowing. Similar results were also obtained by Kumar et al. (2007) and Narayan et al. (2012) in bottle gourd.

The character number of leaves per vine at 45 DAS exhibited positive and significant correlation with fruit yield per vine. Similar findings were reported by Koppad et al*.* (2015b) in ridge gourd.

The character number of branches per vine at 45 DAS exhibited positive and significant correlation with fruit length. Similar findings were reported by Kumar et al*.* (2007) and Narayan et al. (2012) in bottle gourd.

The character days to first staminate flowering exhibited positive and significant correlation with days to first pistillate flowering. Similar observations were recorded by Kumar et al. (2013) and Pandey et al. (2012) in sponge gourd.

The character days to first pistillate flowering exhibited positive significant correlation with days to first harvest after sowing and fruit set percent. Similar trend was also reported by Narayanankutty et al. (2006) and Padmaraja et al. (2014) in snake gourd.

The character number of first appearance of staminate flower showed negative and significant correlation with fruit yield per vine. Similar finding were reported by Janaranjani and Kanthaswamy et al. (2015) in bottle gourd.

The character number of nodes at which first appearance of pistillate flower exhibited positive and significant correlation with days to first harvest after sowing. Similar results were reported by Narayan et al. (2012).

The character days to first harvest after sowing exhibited negative and significant correlation with yield per vine. Similar results were reported by Rahaman et al. (2002).

The character sex ratio exhibited positive and significant correlation with fruit length and positive with non significant correlation with fruit yield per vine. Similar results were reported by Husna et al. (2011) and Janaranjani and Kanthaswamy (2015) in bottle gourd.

The character number of fruits per vine exhibited positive and significant correlation with yield per vine. Similar results were reported by Kumar et al. (2013) in sponge gourd, Padmaraja et al (2014) in snake gourd.

The character fruit length exhibited positive and significant correlation with fruit set percent and yield per vine. Similar results were reported by Padmaraja et al. (2014) and Narayanankutty et al. (2006) in snake gourd.

The character fruit girth exhibited positive and non significant correlation with yield per vine. Similar results were reported by Janaranjani and Kanthaswamy (2015) in bottle gourd.

The character average fruit weight exhibited positive and significant correlation with yield per vine. Similar results were reported by Narayanankutty et al. (2006) in snake gourd and Pandey et al. (2012) in sponge gourd.

5.4 Path coefficient analysis

Though correlation analysis indicates the association pattern of component traits with yield, they simply represent the overall influence of path coefficient analysis developed by Wright (1921) and domesticated by Dewey and Lu (1959) facilitates the portioning of correlation coefficient into direct and indirect contribution of various characters on yield. It is standard partial regression coefficient analysis. As such, it measures the direct influence of one variable upon other. Such information would be great values in enabling the breeder to specifically identify the important components of yield and utilize the genetic stock for improvement in a planned way.

Path analysis also measures the relative importance of caused factor involved. This is simply a standardized partial regression analysis, where in total correlation values were subdivided into individual causal factor.

Correlation coefficient is the indication of simple association between variables. In a biological system, however the relationship may exist in a very complex form. It is therefore, essential to study the relationship among variables in a comprehensive way. Path coefficient analysis is a powerful tool which enables portioning of the given relationship in its further components. In other words, it takes into account not only the relationship of components character with the dependent character, but simultaneously takes care of its relationship with other component also. Thus, it helps in understanding the casual system in a better way because it enables portioning the total correlation coefficient into direct and indirect effects of various characters.

In the present investigation, path coefficient analysis was carried out for character under study using genotypic and phenotypic correlation coefficient and taking fruit yield per vine as dependent variable, in order to see the casual factor and so as to identify the components which are responsible for producing fruit yield per vine.

The results revealed that the characters *viz.,* days to first harvest after sowing, number of fruits per vine, days to first pistillate flowering, number of branches per vine at 45 DAS, vine length at 45 DAS, number of nodes at which first appearance of staminate flower, number of leaves per vine at 45 DAS, sex ratio, number of node at which first appearance of pistillate flower had positive direct effect on fruit yield per vine. These results are in confirmation with those of Narayanankutty et al. (2006), Khan et al. (2009), Choudhary et al. (2008). Whereas, days to first staminate flowering (-7.261) had the highest negative direct effect on fruit yield per plant followed by fruit length (-6.585), fruit set percentage (-5.590), fruit girth (-3.141), average fruit weight (-0.740) had negative direct effect. These results are in confirmation with Kumar et al. (2013), Khan et al. (2009), Padmaraja et al. (2014) and Choudhary et al. (2008).

Vine length at 45 DAS imparted positive indirect effect on fruit yield per plant via number of fruits per vine, days to first pistillate flowering, average fruit weight. However, indirect effect was negative via number of nodes at which first appearance of pistillate flower, fruit length, fruit girth. The results are in propinquity with Padmaraja et al. (2014) and Dewan et al. (2014).

Days to first harvest after sowing imparted positive indirect effect on fruit yield per vine via number of nodes at which first appearance of pistillate flower. However, negative indirect effect was expressed via days to first pistillate flowering, number of fruits per vine. Similar finding was recorded by Padmaraja et al. (2014).

Sex ratio imparted positive indirect effect on fruit yield per vine via fruit girth. However, negative indirect effect was expressed via fruit length, number of fruits per vine, vine length at 45 DAS, average fruit weight. Similar findings was recorded by Dewan et al. (2014)

Number of fruits per vine imparted positive indirect effect on fruit yield per vine through vine length at 45 DAS. However, negative indirect effect was expressed via days to first pistillate flowering, days to first harvest after sowing. Similar finding were recorded by Padmaraja et al. (2014).

Fruit length imparted negative indirect effect was expressed via number of node at which first appearance of pistillate flower, days to first harvest after sowing. Similar finding were recorded by Padmaraja et al. (2014).

Average fruit weight imparted positive indirect effect on fruit yield per vine through number of fruits per vine. However, negative indirect effect was expressed via days to first harvest after sowing and fruit girth. Similar finding were recorded by Padmaraja et al. (2014).

An overall observation of path coefficient analysis revealed that positive direct effect on fruit yield per vine were exerted by the characters viz., days to first harvest after sowing, number of fruits per vine, days to first pistillate flowering, number of branches per vine at 45 DAS, vine length at 45 DAS, number of nodes at which first appearance of staminate flower, number of leaves per vine at 45 DAS, sex ratio and number of node at which first appearance of pistillate flower and selection of these characters may be fruitful for obtaining higher fruit yield in sponge gourd.

5.5 Chlorophyll content index (CCI)

The chlorophyll content was high in the leaves of the genotype SG102 recorded maximum chlorophyll content index 64.03, 79.13 and 86.00 at 15, 30 and 45 DAS respectively, where as the genotype Priya recorded minimum chlorophyll content index 43.13, 58.40 and 64.10 at 15, 30 and 45 DAS respectively. Higher the number of leaves might have lead to the more amount of chlorophyll accumulation in the particular genotype and lead to the more yield.

The chlorophyll content in the leaves is directly proportional to the yield of the plant. These findings are in compliance with earlier workers Hiscox and Israelstom (1979), Bates et al. (1973) and Simuzu et al. (2005).

5.6 Relative water content (RWC %)

Relative water content is a useful indicator of plant water balance, since it expresses the relative amount of water present on the plant tissues. On the other hand, water potential measures the energetic status of water inside the leaf tissue.

Relative water content ranges between 70.56 to 86.31 and 72.81 to 86.90 with the average relative water content index 90.61 and 83.09 at 30 and 45 DAS respectively. The genotypes VRSG8 recorded maximum relative water content 86.31 and 86.90 at 30 and 45 DAS respectively, where as the genotype SG101 recorded minimum relative water content 70.56 and 72.81 at 30 and 45 DAS respectively. These findings are in compliance with earlier worker Yamasaki and Dilenburg (1999).

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FURTHER WORK

The present investigation entitled "Studies on Genetic Variability, character association and physiological analysis in sponge gourd *(Luffa cylindrical (M.) Roem)*'' was undertaken on fifteen genotypes of sponge gourd. The experiment was laid in Randomized Complete Block Design with three replications during 2015-16.

The genotype VRSG140 recorded maximum vine length as well as number of leaves at 15, 30 and 45 DAS, respectively. The genotype SG103 had the highest number of branches at 15, 30 and 45 DAS, respectively and maximum days to first harvest after anthesis and days to first harvest after sowing. The genotype NS441 recorded maximum days to first staminate flowering. The genotypes Kashi Divya recorded maximum days to first pistillate flowering and maximum pistillate flowers. The genotypes Vidhya172 recorded maximum number of nodes at which to first appearance of staminate flowers and fruit girth. The genotypes SG102 recorded maximum number of nodes at which to first appearance of pistillate flowers and maximum chlorophyll content index at 15, 30 and 45 DAS, respectively. The genotype SG103 recorded maximum days to first harvest after sowing and maximum days to first harvest after anthesis. The genotype NS441 also recorded maximum days to first harvest after anthesis. The genotypes VRSG2/13 recorded maximum number of staminate flowers, number of fruits per vine, fruit length, fruit weight, fruit set percentage, fruit yield per vine, fruit yield per plot and fruit yield per hectare. The genotype VRSG182 recorded maximum sex ratio and genotype VRSG8 recorded maximum Relative water content at 30 and 45 DAS, respectively.

Highest Phenotypic coefficient of variation was recorded for the characters viz., number of nodes at which first appearance of staminate flower followed by vine length at 15 DAS, number of nodes at which first appearance of pistillate flower, number of leaves per vine at 15 DAS, fruit yield per vine, fruit length, average fruit weight, number of fruit per vine, fruit yield per plot, fruit yield per hectare, number of branches at 15 DAS and number of branches at 45 DAS. However, low phenotypic coefficient of variation was observed in vine length at 30 DAS.

The values of genotypic coefficient of variation was observed higher for number of nodes at which first appearances of staminate flower followed by vine length at 15 DAS, number of leaves per vine at 15 DAS, number of nodes at which first appearances of pistillate flower, fruit yield per vine, number of branches per vine at 45 DAS, fruit yield per plot, fruit yield per hectare and number of branches per vine at 15 DAS, whereas, low was recorded for average fruit weight.

The characters which showed higher genotypic as well as phenotypic coefficient of variation were number of nodes at which first appearance of staminate flower, vine length at 15 DAS, number of leaves per vine at 15 DAS, number of nodes at which first appearance of pistillate flower, fruit yield per vine, number of branches per vine at 45 DAS, fruit yield per plot and fruit yield per hectare indicating predominance of additive gene action in the inheritance of these characters revealing likelihood of favorable response to selection by these characters.

In respect of other characters studied, presence of low genotypic coefficient of variation as well as phenotypic coefficient of variation indicated predominance of non additive type of gene action in the inheritance for vine length.

High heritability estimates were recorded for the characters viz., number of staminate flowers per vine followed by fruit girth, number of branches per vine at 45 DAS, fruit yield per plot, fruit yield per hectare, vine length at 15 DAS, number of pistillate flower per vine, number of branches per vine at 15 DAS, days to first harvest after sowing, number of leaves per vine, number of nodes at which first appearance of staminate flower, days to first harvest after anthesis, vine length at 45 DAS, number of leaves per vine at 45 DAS, days to first pistillate flowering, number of fruits per vine, sex ratio, average fruit weight, number of leaves per vine at 30 DAS, fruit length, vine length at 30 DAS which indicated that they were least influenced by environmental modification. It reflected that the phenotypes were the true representative of their genotypes and selection based on phenotypic performance would be reliable. Moderate estimated were recorded for days to first staminate flowering followed by fruit yield per vine, number of branches per vine at 30 DAS, fruit set percentage and number of nodes at which first appearance of pistillate flower

The highest percent of expected genetic advance to the extent of 87.38 Percent was noted for the character number of nodes at which first appearance of staminate flower followed by vine length at 15 DAS, while moderate values ware recorded for number of leaves per vine at 15 DAS, number of branches per vine at 45 DAS, fruit yield per plot, fruit yield per hectare, number of branches per vine at 15 DAS, fruit yield per vine, number of nodes first appearance of pistillate flower, average fruit weight, fruit length and number of leaves per vine at 30 DAS.

High heritability coupled with high genetic advance as percentage of mean was exhibited by the characters *viz*., number of nodes at which first appearance of staminate flower and vine length at 15 DAS. Thus, suggesting the preponderance of additive genes. It also indicated higher response for selection of these characters to get high yielding genotypes as they are governed by additive gene actions.

High heritability supplemented with moderate genetic advances as percentage of mean was manifested by number of branches per vine at 45 DAS followed by fruit yield per plot, fruit yield per hectare and number of branches per vine at 15 DAS. This might be attributed to additive gene action conditioning their expression and phenotypic selection for their amenability can be brought about.

High heritability coupled with low genetic advance as percentage of mean was observed for days to first harvest after sowing, number of staminate flowers per vine and fruit girth. This revealed the predominance of non-additive gene action in the expression of these characters.

Low estimates of heritability coupled with low genetic advances as percentage of mean were displayed by number of branches per vine at 30 DAS and days to first staminate flowering that indicated that the characters were highly influenced by environmental effects and consequently its selection would be ineffective.

In present study, phenotypic and genotypic correlation for fruit yield per vine were positive and highly significant with number of leaves per vine at 45 DAS, number of branches per vine, number of fruits per vine, fruit length and average fruit weight. This suggests that while selecting for improvement these characters should be kept in mind provided the characters also show high variability.

Number of leaves per vine at 45 DAS showed positive and significant correlation with number of branches per vine at 45 DAS, fruit set percentage, days to first pistillate flowering, sex ratio and fruit length. However, negative and significant correlation was found in number of nodes at first appearance of staminate flower.

Number of branches per vine at 45 DAS showed positive and significant correlation with fruit set percentage, fruit yield per plant, days to first pistillate flowering, sex ratio and fruit length. However, negative and significant correlations were found in number of nodes at first appearance of staminate flowers and number of nodes at which first appearance pistillate flower.

Days to first staminate flowering showed positive and significant phenotypic correlation coefficient with days to first harvest after sowing and days to first pistillate flowering. However, negative and significant correlation was noted with fruit length.

Days to first pistillate flower showed positive and significant phenotypic correlation coefficient with fruit set percentage and days to first harvest after sowing. However, negative and significant correlations were noted with number of nodes at which first appearance of staminate flower and number of nodes at which first appearance of pistillate flower.

Number of nodes at which first appearance of staminate flower showed positive and significant correlation with number of nodes at which first appearance of pistillate flower. However, negative and significant correlations were noted with number of fruits per vine, fruit set percentage and fruit yield per plant.

Number of nodes at which first appearance of pistillate flower showed positive and significant correlation with days to first harvest after sowing. However, negative and significant correlations were noted with fruit yield vine and number of fruit per vine (0.493)

Days to first harvest after sowing showed negative and significant correlation with fruit yield per plant. Sex ratio showed positive and significant correlation with fruit length and fruit set percentage. Number of fruit per vine showed positive and significant correlation with fruit yield per vine. Fruit length showed positive and significant correlation with fruit set percentage and fruit yield per vine. Average fruit weight showed positive and significant correlation with fruit yield per vine.

In the path analysis, substantial positive direct effect on fruit yield/vine was exerted by days to first harvest after sowing, number of fruits per vine, days to first pistillate flowering, number of branches per vine at 45 DAS, vine length at 45 DAS, number of nodes at which first appearance of staminate flower, number of leaves per vine at 45 DAS, sex ratio and number of nodes at which first appearance of pistillate flower.

CONCLUSIONS

1. The investigation revealed that the genotypes exhibited considerable variation in the morphological, phenological, physiological and yield contributing characters of sponge gourd.
2. The estimates of mean sum of square due to genotypes were highly significant for all the characters indicating the presence of genetic diversity in the existing material.
3. Genotype VRSG2/13 produced the highest fruit yield followed by VRSG2/14, VRSG 182, VRSG 140, VRSG 68-1, VASUDHA 175, NS441, SG 103, VRSG 8, SG 102, KASHI DIVYA, PRIYA, SG 101, VIDHYA 172 and SG 104.

4. The PCV was higher than GCV for all the traits and were higher for characters *viz*., number of nodes at which first appearance of staminate flower followed by vine length at 15 DAS, number of nodes at which first appearance of pistillate flower and number of leaves per vine at 15 DAS.
5. The highest estimate of heritability and Genetic Advance as percentage of mean was recorded in number of nodes at which first appearance of staminate flower followed by vine length at 15 DAS indicating that heritability may be due to additive gene action and selection based on these characters may be effective.
6. Fruit yield per vine showed highly significant and positive correlation with number of leaves per vine at 45 DAS, number of branches per vine, number of fruits per vine, fruit length and average fruit weight. However, negative and significant correlations were noted with number of nodes at which first staminate flower, number of nodes at which pistillate flower and days to first harvesting after sowing.
7. Substantial positive direct effect on fruit yield/vine was exerted by days to first harvest after sowing, number of fruits per vine, days to first pistillate flowering, number of branches per vine at 45 DAS, vine length at 45 DAS, number of nodes at which first appearance of staminate flower, number of leaves per vine at 45 DAS, sex ratio and number of nodes at which first appearance of pistillate flower. Whereas, days to first staminate flowering had the highest negative direct effect on fruit yield per vine followed by fruit length, fruit set percentage, fruit girth and average fruit weight had negative direct effect.

SUGGESTIONS FOR FURTHER WORK

- The amount of variability present was of wide range for all the characters studied, hence, attention needs to be given for these traits during selection for yield improvement.
- Genetic variability analysis of the same genotypes can be studied for more than one year and over the locations to validate the results.
- On the findings of correlation and path analysis, the characters *viz*., number of leaves per vine at 45 DAS, number of branches per vine at

45 DAS, number of fruits per vine, fruit length and average fruit weight can be considered for formulating plant ideotype with high fruit yield in sponge gourd and further utilization in future breeding programme

- Further research with molecular characterization of above identified promising sponge gourd genotypes to provide more accurate measures of genetic diversity should be done.
- Identified genotypes on the *per se* performance should be utilized for crop improvement as crosses between these genotypes can be utilized as productive recombinants and further development of high yielding varieties.

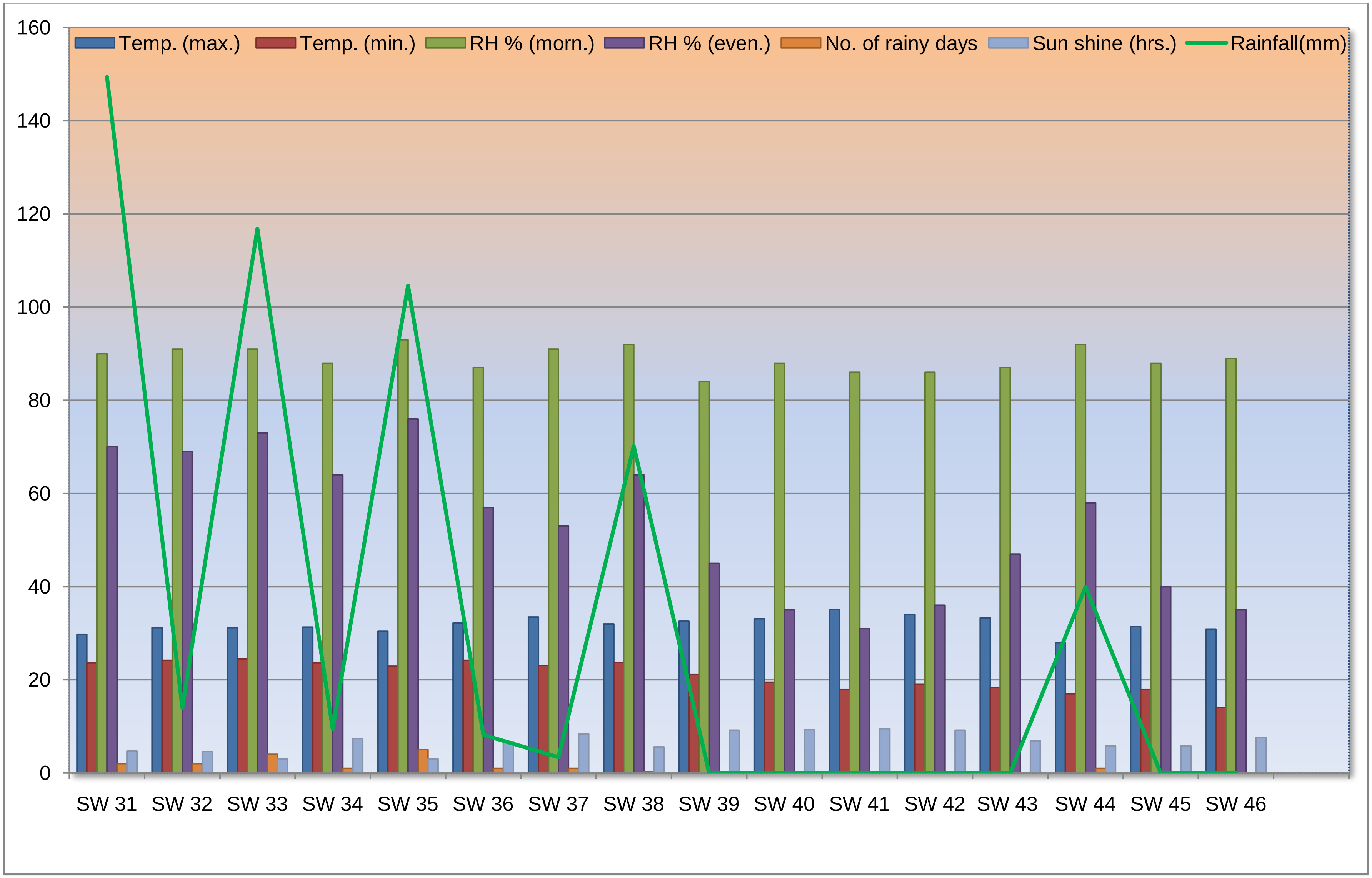


Fig. 1: Meteorological information (week wise) during entire crop season of the year August 2015 to November 2015 at Jabalpur.

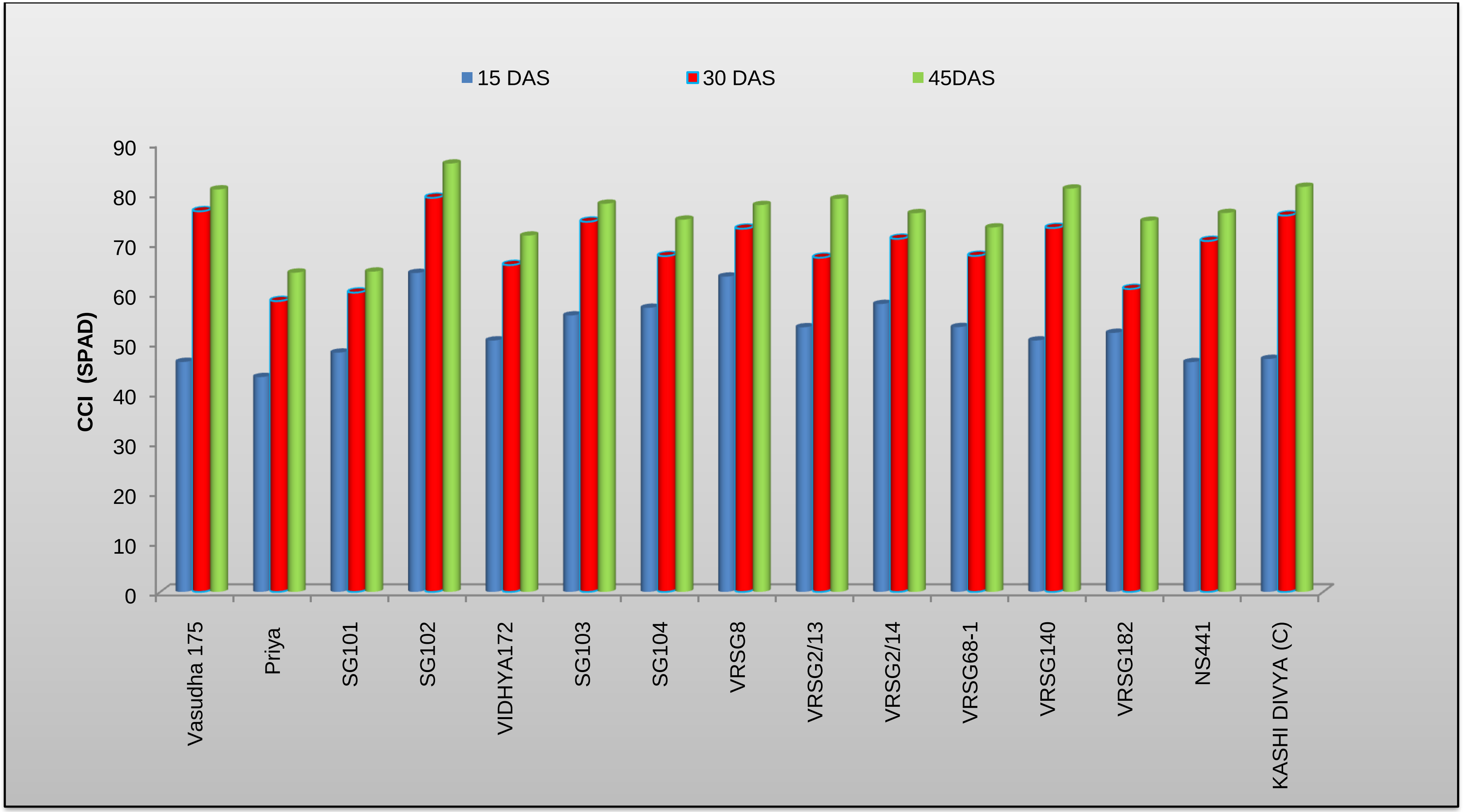


Fig.3: Chlorophyll content index in sponge gourd leaf

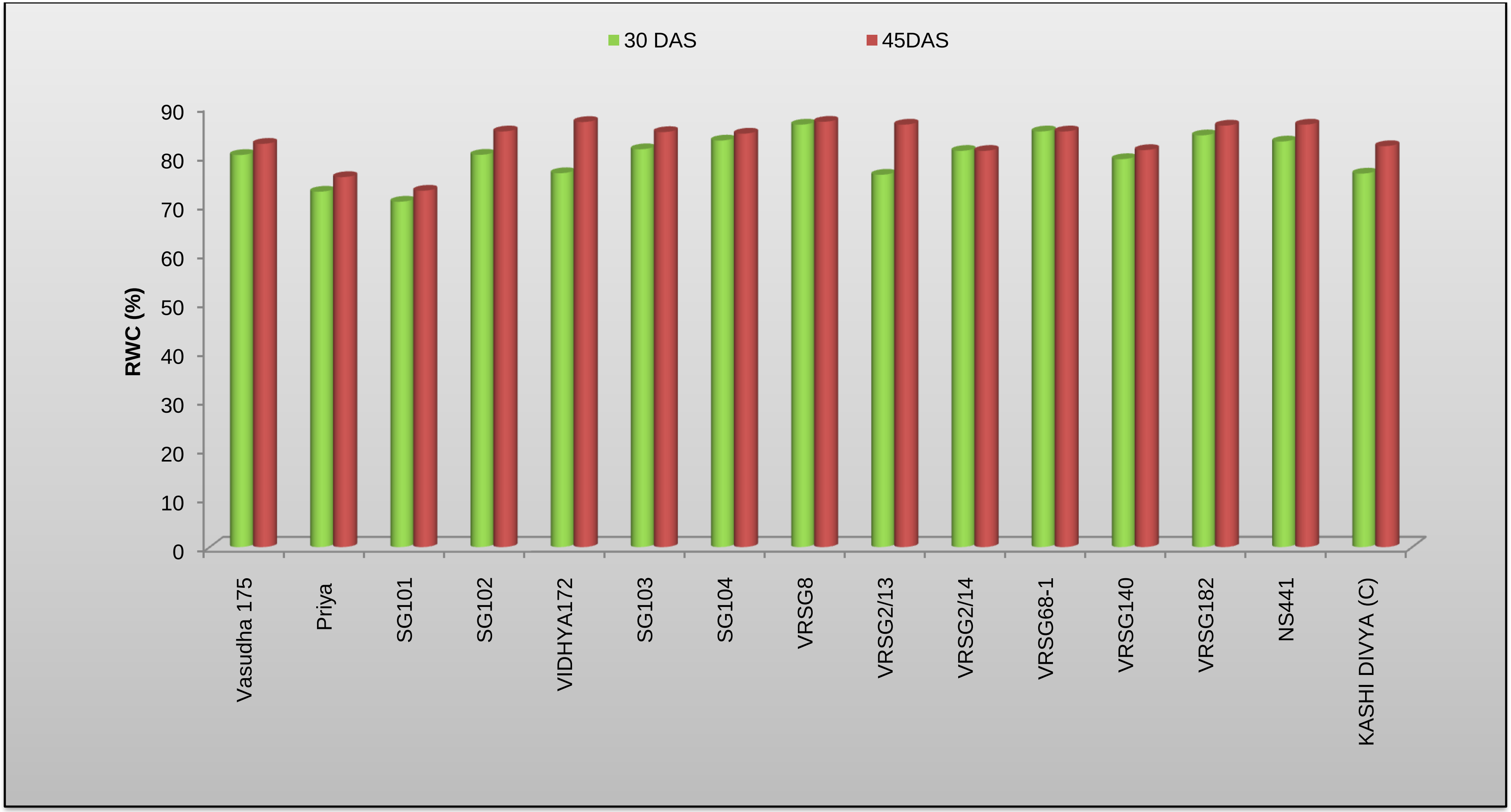


Fig. 4: Relative Water Content in Sponge Gourd Leaf

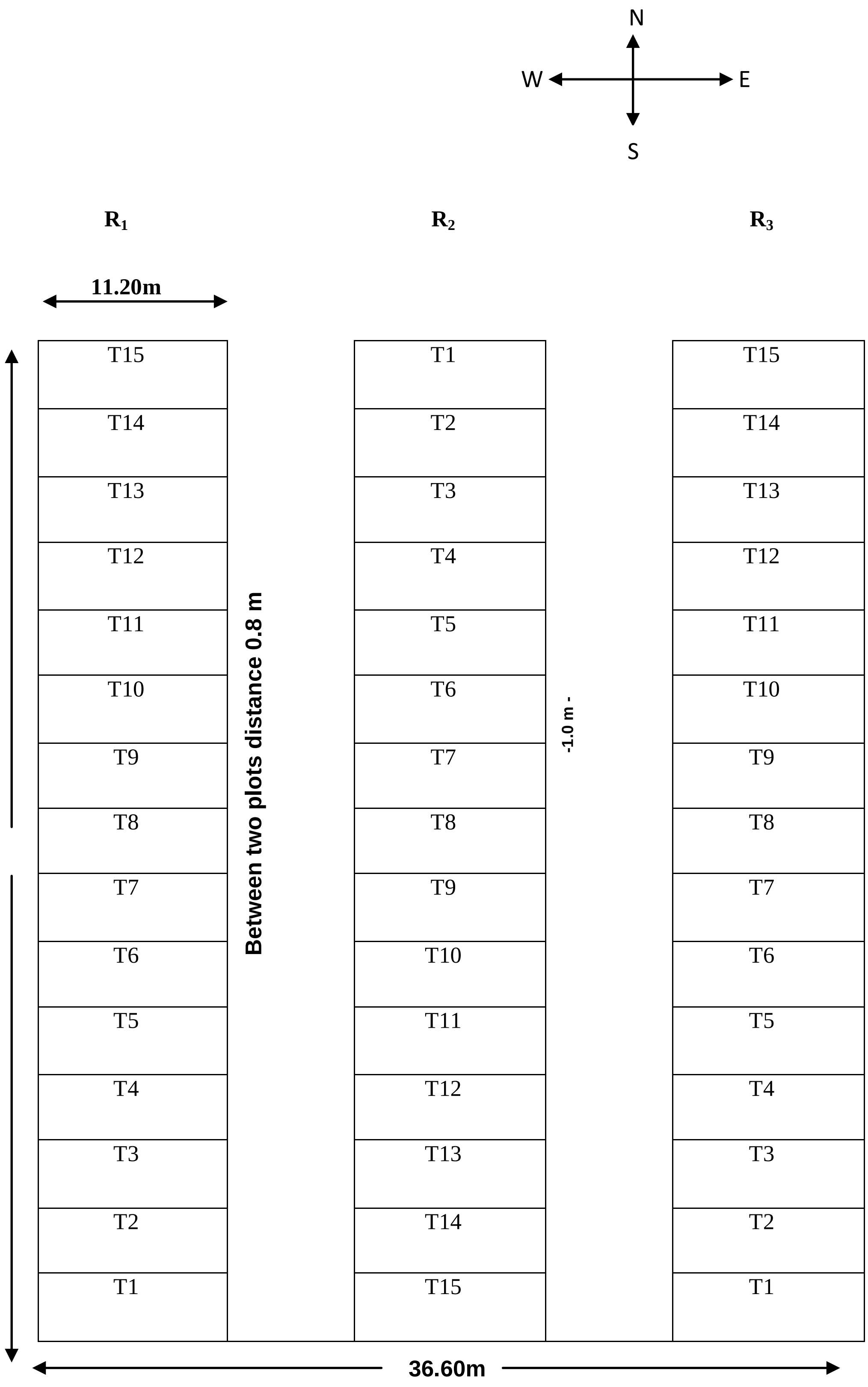


Fig. 2: Layout plan of the experimental field.

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APPENDICES

Analysis of variance for various characters in sponge gourd (mean sum of squares).

Source of variance	D.F.	Vine length (cm)			No. of leaves/vine		
		15 DAS	30 DAS	45DAS	15 DAS	30 DAS	45DAS
Replications	2	448.578	3217.034	11597.071	2.305	427.720	122.823
Genotypes	14	2785.181**	2708.047**	4205.875**	31.891**	125.175**	106.602**
Error	28	67.911	337.708	293.701	3.839	10.227	5.214

Source of variance	D.F.	No. of branches/vine			Days to first flowering	
		15 DAS	30 DAS	45DAS	Staminate	Pistillate
Replications	2	0.124	0.032	0.017	0.228	0.124
Genotypes	14	0.568**	0.340**	1.617**	3.180**	4.153**
Error	28	0.019	0.049	0.016	0.404	0.406

Source of variance	D.F.	No. of nodes at which first flower appearances		Days to first harvest	
		Staminate	Pistillate	After sowing	After anthesis
Replications	2	0.099	7.668	7.198	1.662
Genotypes	14	2.241**	6.836**	7.960**	1.370**
Error	28	0.115	1.634	0.280	0.071

Source of variance	D.F.	No. of flower/vine		Sex ratio (staminate: pistillate)
		Staminate	Pistillate	
Replications	2	47.639	2.592	0.123
Genotypes	14	6696.246**	81.278**	0.811**
Error	28	36.300	2.136	0.087

Source of Variance	D.F.	Chlorophyll content index (CCI) SPAD			Relative water content (RWC %)	
		15 DAS	30 DAS	45DAS	30 DAS	45DAS
Replications	2	5.286	31.598	133.046	14.681	0.502
Genotypes	14	115.254**	116.518**	107.434**	61.227**	51.924**
Error	28	28.935	5.255	21.509	5.570	10.079

Source of Variance	D.F.	Number of fruits/vine	Fruit length (cm)	Fruit girth (cm)	Average fruit weight (g)
Replications	2	73.360	2.405	0.001	190.822
Genotypes	14	54.953**	44.553**	0.218**	689.047**
Error	28	5.623	5.540	0.001	75.004

Source of Variance	D.F.	Fruit set (%)	Fruit yield /vine (kg)	Fruit yield /plot (kg)	Fruit yield/ha (q)
Replications	2	10.563	3.334	9.098	723.977
Genotypes	14	101.220**	0.601**	47.209**	3756.121**
Error	28	22.878s	0.082	1.100	87.608

PART I OF ABSTRACT

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ABSTRACT

The present experiment was carried out in the research field of KVK, Jawahar Lal Nehru Krishi Vishwa Vidyalaya, Jabalpur during *Kharif* season, 2015-2016.

The experiment was laid out in Randomized Complete Block Design (RCBD) with fifteen genotypes in three replications. The plot size was kept 11.20 m x 1.0 m. The row to row distance was 1 m and plant to plant distance was 80 cm. The observations were recorded on eighteen morphological, phenological and physiological traits with the main objectives to estimate parameters of genetic variability, assess correlation coefficient between yield and its attributing traits and to determine direct and indirect effect of yield component on fruit yield per vine in fifteen sponge gourd genotypes. Eight genotypes were collected from IIVR, Varanasi viz., VRSG 8, VRSG2/13, VRSG 2/14, VRSG68-1, VRSG 140, VRSG 182, NS441 and KASHI DIVYA and seven genotypes from UPL Limited, namely Vasudha 175, Priya, SG101, SG102, SG103, SG104 and Vidhya 172.

The genotype VRSG140 recorded maximum vine length (162.44 cm, 201.73 cm and 382.47cm) and number of leaves (21.60, 56.20 and 84.08) at 15, 30 and 45 DAS, respectivaly. Genotype SG103 recorded the highest number of branches (3.60, 3.66 and 5.67) at 15, 30 and 45 DAS, respectively and maximum days to first harvest after sowing (37.66) and anthesis (9.37).

The genotype SG102 recorded maximum number of node at which first appearance of pistillate flowers (9.29) and maximum Chlorophyll content index 64.03, 79.13 and 86.00 at 15, 30 and 45 DAS, respectively. The genotype VRSG2/13 produced maximum number of staminate flowers (470.56), number of fruits per vine (35.06), fruit length (35.60 cm), fruit weight (122.22g), fruit set percentage (84.42), fruit yield per vine (3.14kg), fruit yield per plot (33.06kg) and fruit yield per hectare (294.90kg).

The genotype Vidhya172 recorded maximum number of node at which first appearance of staminate flowering (4.21), girth of fruit (3.11 cm). The genotype NS441 recorded maximum days to first staminate flowering 26.20 and Kashi Divya recorded maximum pistillate flowering (28.00) and number of pistillate flowers (57.11). The genotypes VRSG182 recorded maximum sex ratio 8.94 and the genotype VRSG8 recorded maximum relative water content 86.31 and 86.90 at 30 and 45 DAS, respectively.

The analysis of variance revealed significant differences among genotypes for all the characters under study. Results revealed that PCV was higher than the GCV for all the characters. Higher phenotypic as well as genotypic coefficient of variation was recorded for number of nodes at which first appearance of staminate flower, vine length at 15 DAS, number of leaves per vine at 15 DAS, number of nodes at which first appearance of pistillate flower, fruit yield per vine, number of branches per vine at 45 DAS, fruit yield per plot and fruit yield per hectare.

High heritability coupled with high genetic advance as percentage of mean was exhibited by number of nodes at which first appearance of staminate flower and vine length at 15 DAS. This indicated the preponderance of additive genes. High heritability supplemented with moderate genetic advances as percentage of mean was manifested by number of branches per vine at 45 DAS followed by fruit yield per plot, fruit yield per hectare and number of branches per vine at 15 DAS. High heritability coupled with low genetic advance as percentage of mean was observed for days to first harvest after sowing, number of staminate flowers per vine and fruit girth. Low estimates of heritability coupled with low genetic advances as percentage of mean were displayed by number of branches per vine at 30 DAS and days to first staminate flowering.

On the basis of genotypic and phenotypic correlation coefficient analysis, the characters viz., number of leaves per vine, number of branches per vine, number of fruits per vine, fruit length and average fruit weight showed positive and significantly correlated with fruit yield per vine.

Path analysis indicated that direct effect on fruit yield/vine were exerted by days to first harvest after sowing, number of fruits per vine, days to first pistillate flowering, number of branches per vine at 45 DAS, vine length at 45 DAS, number of nodes at which first appearance of staminate flower, number of leaves per vine at 45 DAS, sex ratio and number of nodes at which first appearance of pistillate flower.

CURRICULUM VITAE

The author of this thesis, Mr. Nilesh Sharma S/o Shri Subhash Sharma and smt. Sharmila Sharma was born on 23 January, 1992 at Dhamnod in Ratlam (MP).

After graduation, for further study, he got admission in M.Sc. (Ag.) for specialization in Horticulture (vegetable science) at the college of Agriculture, JNKVV, Jabalpur (M.P) where successfully completed all the course requirement for master's degree with OGPA 7.57 out of 10 point scale in the year 2014.

For the partial fulfillment of the master's degree "Study on Genetic Variability, Character Association and Phisiological Analysis in Sponge Gourd." under Jabalpur condition, which was successfully conducted by him and being submitted in the form of this thesis.

He took admission for B.Sc. (Ag.) in the College of Horticulture, Mandsaur, Rajmata Vijayaraje Krishi Vishwa Vidalaya Gwalior (MP) in the year 2011. He has successfully completed his graduation with 7.79 OGPA in the year 2014.

He passed his High School (10th) with first division (80%) in the year 2007 and Higher Secondary School (12th) with first division (76%) in the year 2009 from School for Excellence (No.2), Ratlam (MP).