Estimates of genetic variability, heretability, genetic advance and genetic divergence in bottle gourd [*Lagenaria siceraria* (Mol.) Stadle.]

ABSTRACT

The present investigation was conducted at Department of Vegetable Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur-208002 (UP) during *Kharif* season in 2022. During the study the analysis of variance for 32 genotypes of Bottle gourd in the randomized block design and revealed significant difference for all the 11 characters, this indicated the presence of wide spectrum of variability among the genotypes. The phenotypic coefficient of variation (PCV) was higher than the respective genotypic coefficient of variation (GCV) for all the traits, a narrow difference between PCV and GCV were recorded for all of the traits. High heritability and genetic advance as per cent of mean were observed for all eleven characters. The highest heritability was recorded in vine length and lowest for number of primary branches. The analysis of genetic divergence through Mahalanobis D^2 statistics revealed that a considerable genetic diversity was found among genotypes. 32 genotypes of bottle gourd were grouped into 5 clusters. Out of the 5 clusters, Cluster IV had ten genotypes, Cluster III had eight genotypes, Cluster II had eight genotypes, Cluster I had three genotypes and Cluster V had three genotypes. Based on present investigation, it was concluded that in general, there was parallelism between genetic and geographic diversity. Maximum inter cluster distance was determined between clusters III and cluster V so crosses among genotypes of cluster III like KLG (8), AZAD HARIT (9), BG-7505 (10), BG-7127, BG-7512, BG-7306, BG-7502 and BG-7231 can be made as a parent for getting better hybrids.

Keywords: Genetic variability; heritability; genetic advance; bottle gourd; genetic divergence etc.

INTRODUCTION

Bottle gourd [*Lagenaria siceraria* (Mol.) Stadle.] is a popular vegetable crop in India. It belongs to the Cucurbitacea family and has chromosome number 2n = 22. It is grown in the

majority of states, including Uttar Pradesh, Bihar, West Bengal, Assam, Punjab, and Gujarat. The fossil records show that it was cultivated in India before 2000 B.C. and was the first plant domesticated in America (**Peter, 1998**). According to **Culter** and **Whittaker**, the bottle gourd originated in Africa and is most likely endemic to tropical Africa. **De Condole** reported seeing it in the wild in South Africa and India. The bottle gourd belongs to the genus *Lagenaria* and was formerly thought to be monoecious, but it has recently been revealed to include dioecious and perennial species (**Pitchaimuthu, 1991**). It is cultivated both in the summer and in the rainy season (**Yadav *et al.,* 2010**). The common moniker bottle gourd derives from the bottle's fruit-like form and usage as a container for wines and spirits in the post. Bottle gourd is an annual soft vine that is monoecious and strongly cross pollinated. Cross pollination occurs at a rate of 60-80% (**Choudhary, 1979**). Bottle gourd fruits come in cylindrical, circular oval, and oblong shapes. Bottle gourd may be grown in any type of soil, although it grows best in thoroughly manured loam soil. It prefers a warm, humid climate, but it can also be grown in dry periods with lots of watering. In general, India grows two crops. Summer crops are cultivated from the middle of October to the middle of March, and the next harvest is grown from the beginning of March to the middle of July. The edible component of bottle gourds is composed mostly of 96.1 percent water, 0.1 percent fat, 2.5 percent carbs, 0.2 percent protein, and 2.0 percent fibre **(Singh ,2014)**. For consumption outside of peak season, the fruits are also canned. It is advised for use during convalescence since it is easily digested. It has cooling capabilities. A leaf decoction can be used as a treatment for jaundice. The pulp works well to treat conditions including constipation, cough, night blindness, and acts as an antidote to several poisons **(Chauhan ,1972)**. To lessen the effects of heat during the summer, people massage the sliced surface of small-sized fruit on their hands and feet. India, Sri Lanka, Indonesia, Malaysia, the Philippines, China, Hong Kong, Tropical Africa, Columbia, and Brazil are the top producers of bottle gourd. In India, its share is roughly 186 thousand hectares with a production of 3052 thousand metric tonnes (**NHB - 2018-19 3rd advance estimate**). It covers 14.40 thousand acres in Uttar Pradesh and produces 427.81 MT/ha (**NHB - 2018**). Agra district leads Uttar Pradesh in both area (0.95 thousand acres) and output (27.78 thousand metric tonnes) (**NHB - 2016-17**).But because of the strain from the growing population, productivity needs to be improved. One factor contributing to the bottle gourd's low yield is the vine's tendency to produce fewer female flowers than male flowers. Furthermore, the bulk of the less productive farmers plant the native varieties of bottle gourd. The crop becomes infected with diseases including Fusarium wilt, anthracnose, powdery mildew, and mosaic as well as pests such the red pumpkin beetle, aphids, mites,

fruit fly, nematodes, etc. This results in a marked decrease in output. The critical and initial phases in every crop development strategy are the collection, preservation, and assessment of germplasm. A good breeding scheme must be created with a better understanding of the kind and degree of genetic diversity contained in the breeding material. In addition to various other features that contribute to yield, which are often quantitatively inherited and heavily impacted by the environment, yield is a complicated property. As a result, it is challenging to determine whether or not the observed variability is heritable. In order to understand the nature of inheritance of various characteristics, it is helpful to grasp the key variability parameters such as variance, phenotypic variance, genetic progress, and heritability. An important tactic used to overcome genetic yield restrictions is the assessment of the degree of association between different features. Determining the elements of a difficult attribute like yield is made easier by this study. However, correlation alone cannot accurately measure the direct and indirect effects on yield. Breeders may find this information helpful in choosing high producing genotypes for a crop. Mahalanobi's 'D^{2}' static technique, which is based on multivariate analysis of quantitative features, is a potent tool for assessing genetic diversity employing the idea of statistical distance utilizing many measurements. Since it enables accurate comparison across all potential population pairings before altering the actual crossings, the application of this statistical approach in classification issues has been strongly suggested (**Rao, 1952**). The phenomena of sex expression in cultivars is influenced by genetic and environmental [Light and Temperature] (**Tiedjens, 1928** and **Nilsch *et al*., 1952**) variables, and it has been efficiently manipulated by the use of nitrogen and growth regulators. Several workers in India and other countries have attempted to boost production by adding a large number of female flowers and greater fruit set with nitrogen treatment. Increased nitrogen level and application strategy resulted in increased yield. Farmers are currently in desperate need of developing early maturing and high producing varieties/hybrids. Early maturing genotypes can be identified preliminary based on characteristics such as days to first female flower, days to first female blooming, and days to first fruit harvest. Germplasm collection and assessment are required before it can be used, and rigorous evaluation defines the potential of an accession in a given crop development plan. As a result, a characterization and assessment trial of currently available bottle gourd germplasm was conducted in order to discover viable cultivars with various horticultural features.

MATERIAL AND METHODS

The investigation on **"Estimates of Genetic parameters, correlation and path coefficient analysis in bottle gourd [*Lagenaria siceraria* (Mol.) Stadle.]"** comprise of a field experiment which was carried out at the Vegetable Science Research Farm, Chandra shekhar azad university of agriculture and technology, Kanpur during *kharif* season 2022. The university is located about 70 km away from lucknow (State Capital of Uttar Pradesh), which is situated at an altitude of 127 meters. The latitude being 26.40°N and longitude 80.10°E at elevation of 125.90m above mean sea level. The experimental site's land topography was mostly homogeneous, with good surface drainage. The experimental location has a modest internal drainage system. During Kharif 2022, thirty two different bottle gourd genotypes were assessed for a variety of yield and yield contributing factors at the Experimental Field of the Department of Vegetable Science "Chandra Shekhar Azad University of Agriculture and Technology Kalyanpur Kanpur, Uttar Pradesh". A single factor experiment with three replications of each accession per plot was set up using a randomised block design (RBD). The three blocks (experimental units) that made up the entire experimental area were each organised into thirty two rows to correspond to the thirty two treatments. Each block received seeds from each genotype at random, with a spacing of 1 m between rows and 0.60 m between seeds. A recommended set of procedures was used to cultivate a robust crop. The observation were recorded for the following characters viz. number of primary branches, length of internode of main stem, days to first male flower, days to first female flower, days to first fruit harvest, length of the fruit, number of fruits per plant, vine length, seed length, seed width and fruit yield per plant. The mean values of genotypes in each replication were used for statistical analysis. The data were analyzed for a randomized block design to test the significance of differences between the genotypes for various characters described by **Panse and Sukhatme (1967)**. The genotypic and phenotypic coefficients of variation were calculated as per the formula suggested by **Burton (1952)**.

$$\text{Genotypic coefficient of variance} = \frac{\sqrt{\sigma^2 g}}{x} \times 100$$

$$\text{Phenotypic coefficient of variance} = \frac{\sqrt{\sigma^2 p}}{x} \times 100$$

GCV and PCV values were categorized as low (0-10%), moderate (11-20%) and high (> 20%) as indicated by **Sivasubramaniam and Menon (1973)**. Heritability (broad sense) was calculated as per **Lush (1949), Burton and Devance (1953),** and **Weber and Moorty (1952)**.

$$h^2 = \frac{\sigma^2 g}{\sigma^2 p} x100$$

The heritability percentage was categorized as low (0-30%), moderate (30 -60 %) and high (>60%) as given by **Johnson *et al*.** and genetic advance as per **Johnson *et al***. were also worked out. Genetic advance as per cent of mean was categorized as low (0-10%), moderate (11 – 20%) and high (>20%) as suggested by **Johnson *et al*.**

$$G.A. = h^2 (b) \times \sigma \square \times k$$

The genetic divergence in twenty genotypes was estimated using **Mahalanobis** D^2 statistic (1936) following **Rao (1952)**.

Table 1. Mean sum squares of 32 genotypes of bottle gourd for 11 characters

Source of variation	df	Number Of primary branches	Length of internode of main stem (c.m.)	Days to male flower (days)	Days to female flower (days)	Days to first fruit harvest (days)	Length of the fruit (c.m.)	Number Of fruits per plant	Vine length (c.m.)	Seed length (c.m.)	Seed width (c.m.)	Fruit yield per plant (kg)
Repl	2	0.078	1.19	1.22	1.49	2.26	6.64	0.21	196.54	0.0230	0.0005	1.03
Treat	31	0.614**	9.57**	31.82**	30.02**	35.02**	74.19**	8.26**	7676.32**	0.0515**	0.0043**	15.52**
Error	62	0.111	0.44	2.70	2.55	2.37	5.10	0.31	116.61	0.0073	0.0006	0.27
Total	95	0.275	3.44	12.17	11.49	13.02	27.68	2.90	2585.14	0.0221	0.0018	5.26

*, ** significant at 5% and 1% level, respectively

Table 2. Genetic variability of 32 genotypes of bottle gourd for 11 characters

Genotypes	Mean	Min	Max	var (g)	var (p)	Heritability (%)	GA	GA% mean	GCV (%)	PCV (%)	% cont
Number Of primary branches	3.44	2.57	4.00	0.17	0.28	60.10	0.65	19.04	11.92	15.37	11.58
Length of internode main stem (cm)	11.40	9.00	16.22	3.04	3.49	87.28	3.36	29.45	15.30	16.38	8.72
Days to first male flower	44.35	38.33	50.78	9.71	12.41	78.23	5.68	12.80	7.03	7.94	9.87

Days to first female flower	46.77	42.56	54.00	9.15	11.71	78.20	5.51	11.78	6.47	7.32	11.68
Days to first fruit harvest	71.99	60.33	76.67	10.88	13.25	82.13	6.16	8.56	4.58	5.06	9.83
Length of the fruit (c.m.)	29.87	19.67	39.22	23.03	28.13	81.87	8.95	29.95	16.07	17.76	8.91
Number Of fruits per plant	6.30	3.11	8.89	2.65	2.96	89.48	3.17	50.36	25.84	27.32	7.78
Vine length (c.m.)	656.49	534.22	806.56	2519.91	2636.51	95.58	101.10	15.40	7.65	7.82	6.05
Seed length (c.m.)	1.57	1.27	1.80	0.01	0.02	66.81	0.20	13.01	7.73	9.46	9.39
Seed width(c.m.)	0.24	0.19	0.31	0.00	0.00	65.32	0.06	23.77	14.28	17.67	9.40
Fruit yield per plant (kg)	6.83	2.94	11.49	5.08	5.36	94.91	4.52	66.25	33.01	33.88	6.81

*GA: Genetic advance *var (p): Phenotypic variance *% cont: Percentage contribution

*var (g): Genotypic Variance *GCV: Genotypic coefficient of variance *PCV: Phenotypic coefficient of variance

Table 3. Distribution of bottle gourd genotypes in different clusters

Clusters	No of genotypes	Genotypes
I	3	BG-6401, KLG (20), BG-7232
II	8	BG-7002, BG-7303, BG-6802, BG-7304, BG-7302, BG-7505, AZAD HARIT (29), BG-7202
III	8	KLG (8), AZAD HARIT (9), BG-7505 (10), BG-7127, BG-7512, BG-7306, BG-7502, BG-7231
IV	10	BG-7117, BG-7201, BG-6503, BG-7003, BG-7107, BG-7112, BG-7504, AZAD HARIT (21), BG-7503, BG-7509

V	3	BG-7404, BG-8502, BG-7233

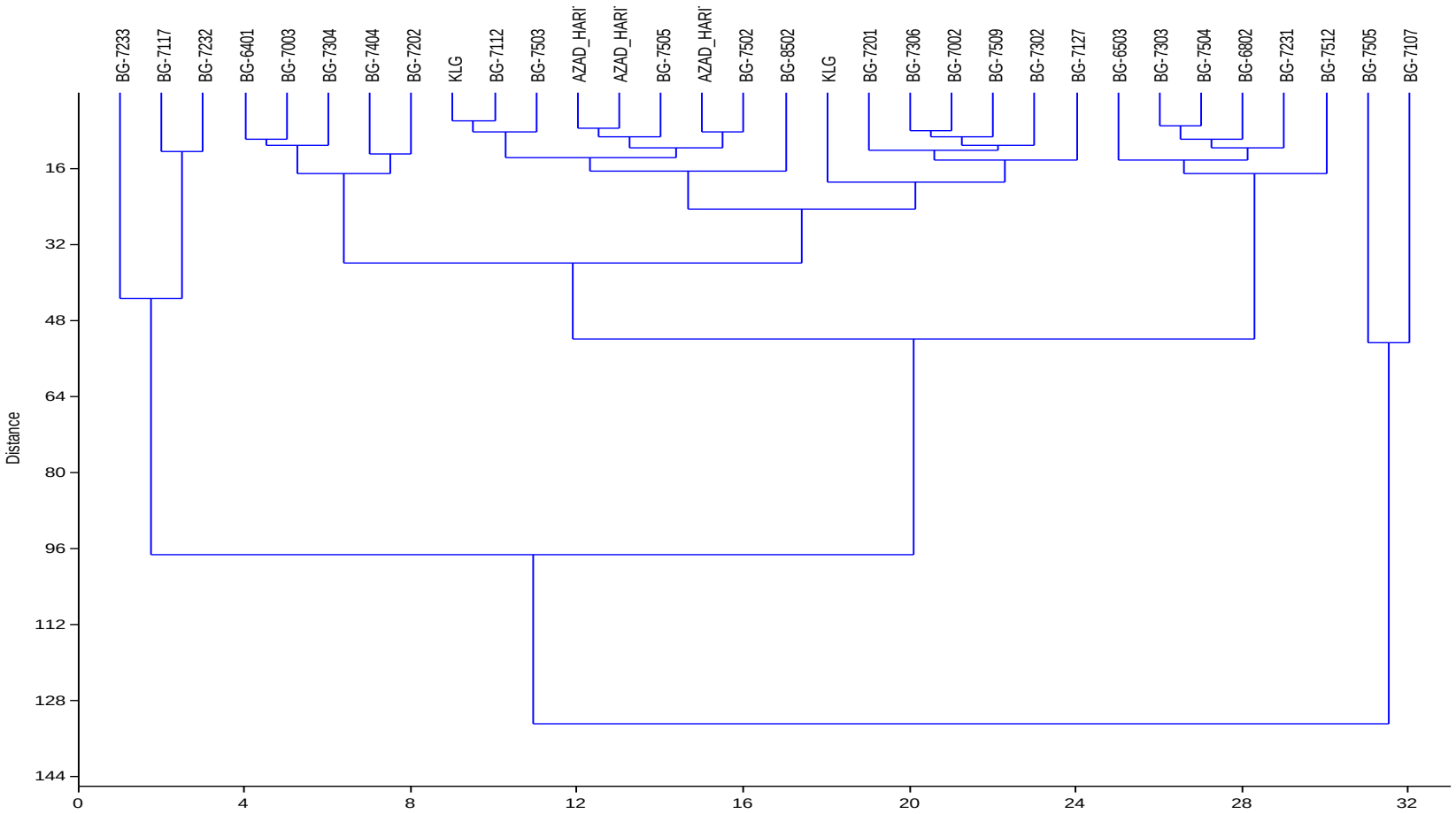

Fig:Clustering by Tocher method (Dendrogram)

Table 4. Inter and intra distances

Clusters	I	II	III	IV	V
I	**2.430**				
II	3.058	**2.200**			
III	3.734	3.402	**2.797**		
IV	3.901	2.989	2.840	**2.395**	
V	4.083	3.176	5.084	5.064	**1.958**

Table 5. Contribution of various characters towards total genetic divergence

S.N.	**Character**	**Contribution %**
1.	Number Of primary branches	11.58
2.	Length of internode of main stem(c.m.)	8.72
3.	Days to first male flower (days)	9.87
4.	Days to first female flower (days)	11.68
5.	Days to first fruit harvest (days)	9.83
6.	Length of the fruit (c.m.)	8.91
7.	Number Of fruits per plant	7.78
8.	Vine length (c.m.)	6.05
9.	Seed length (c.m.)	9.39
10.	Seed width(c.m.)	9.40
11.	Fruit yield per plant (kg)	6.81

RESULTS AND DISCUSSION

1. Analysis of Variance

The analysis of variance for different characters is presented in Table 1. The result showed highly significant differences among thirty two genotypes for different characters under study. These characters were No. of primary branches, Length of internode of main stem, Days to male flower, Days to female flower, Days to first fruit harvest, Length of the fruit, No. of fruits per plant, Vine length, Seed length, Seed width, Fruit yield per plant. **Uddin *et al.* (2018)** showed the same result.

2. Heritability Analysis

Heritability in broad sense was found high for vine length (95.58%), fruit yield per plant (94.91%), number of fruits per plant (89.48%), length of internode of main stem (87.28%), days to first fruit harvest (82.13%), length of fruit (81.87%), days to first male flower (78.23%) and days to first female flower (78.20%) . **Sharma and Sengupta (2013)** and **Singh *et al.* (1996)** showed the high heritability for vine length.

3. Genetic Advance Analysis

During the rainy season, most attributes showed strong genetic advance as a percentage of mean (genetic gain), ranging from 66.25% for fruit yield per plant to 8.56% days to first fruit harvest. Number of fruits per plant (50.36%), length of the fruit (29.95%), length of internode of main stem (29.45%), seed width (23.77%), number of primary branches (19.04%), and vine length (15.40%) were other parameters with strong genetic gain as a percentage of mean.

4. Genetic Divergence

4.1. Clustering pattern

The studies of genetic divergence among the thirty two genotypes of bottle gourd were carried out by using Mahalnobis D^2 statistics. Thirty two genotypes were grouped into five different non-overlapping clusters (Table-4.8). Cluster IV had highest number of genotypes (10) followed by cluster II (8) and cluster III (8). In cluster I and cluster V had 3 genotypes. **Vaibhav (2014)** conducted experiment on 31 genotypes and also got 5 clusters.

4.2 Inter and intra cluster distance

The average intra and inter cluster D^2 presented in Table 5. revealed maximum inter cluster D^2 value (5.084), between cluster III and V followed by cluster IV and V (5.084), whereas the minimum average inter cluster D^2 value (2.840) was recorded between cluster III and IV . The maximum intra cluster distance were found 2.797 for cluster III followed by cluster I (2.430), 2.395 for cluster IV, 2.200 for cluster II, whereas minimum intra cluster value was recorded between cluster V (1.958).

4.3. Contribution Percentage of Each Character towards Total Divergence

The contribution percentages of traits under studied towards total divergence are tabulated in table 6. The highest contribution in the manifestation of genetic divergence was exhibited by days to first female flower contributes maximum (11.68) towards total divergence and this was followed number of primary branches (11.58), days to first male flower (9.87), days to first fruit harvest (9.83), seed width (9.40), seed length (9.39), length of the fruit (8.91), length of internode of main stem (8.72), number of fruits per plant (7.78), fruit yield per plant (6.81), vine length (6.05).

CONCLUSION

The prior discussion shows that there is significant potential for merging the top allelic resources found in these bottle gourd genotypes using a systematic breeding and selection technique in order to recover high producing recombinants with good quality features. Analysis of variance exhibited significant variation among the genotypes for all the characters indicating wide spectrum of variation among the genotypes. . The high PCV and GCV was recorded for the traits like fruit yield per plant, number of fruits per plant, whereas length of the fruit, seed width, length of internode of main stem, number of primary branches showed moderate PCV and GCV while seed length, vine length, days to first male flower, days to first female flower, days to first fruit harvest showed lowest GCV and PCV. Heritability in broad sense was found high for vine length, fruit yield per plant, number of fruits per plant, length of internode of main stem, days to first fruit harvest, length of fruit, days to first male flower and days to first female flower. High genetic advance showed in number of fruits per plant, length of the fruit, length of internode of main stem, seed width, number of primary branches and vine length. The intra cluster distance among various clusters exhibited maximum intra cluster distance for cluster III followed by cluster I and the lowest intra cluster distance was recorded for cluster V. So crosses among genotypes of

cluster V like BG-7404, BG-8502, BG-7233 and genotype of cluster III i.e. KLG (8), AZAD HARIT (9), BG-7505 (10), BG-7127, BG-7512, BG-7306, BG-7502, BG-7231 can be made. Inter cluster distance was determined highest for cluster III and cluster V therefore, genotypes in cluster III can be crossed among themselves to get better result in the breeding programme.

ACKNOWLEDGEMENT

Success is the result of hard work, dedication, inspiration, motivation, and creativity. It is my proud privilege to express my heartfelt appreciation to my Advisor (Dr.) P.K. Singh, Professor and (Dr.) I.N. Shukla, Department of Vegetable Science, CSAUA&T, Kanpur, for his generous assistance, unwavering guidance, supervision, critical suggestions, and positive attitude towards my abilities, which enabled me to complete this work.

Reference

Anonymous. (2018). National Horticulture Board Database, Gurgaon. http:/www.nhb.gov.in.

Anonymous. (2020). National Health Portal, Delhi.http:/www.nhp.gov.in.

Bisognin A.D. (2002). Origin and evolution of cultivated cucurbits. *Ciencia Rural.*,**31(4):**715-723.

Burton, G. W. (1952). Quantitative inheritance in grasses. *Proc. 6th Int. Grass Land. Cong.* **1**: 211-283.

Burton, G.W. and Devane, E. M. (1953), Estimating heratibility in tall fescue (*Festuca cirnelinaceae*) from replicated clonal material. *Agronomy journal* **45:** 479-481.

Chandrashekhar T.; M. Vijaya, P. Saidaiah, Veena Joshi and SR Pandravada (2018) Genetic variability, heritability and genetic advance for yield and yield attributes in bottle gourd (*Lagenaria siceraria* (mol) Standl.) germplasm. *Journal of Pharmacognosy and Phytochemistry;* **7(6):** 2085-2088

Chowdhury, D. and Sharma, K.C. (2002). Studies on variability, heritability, genetic advance and correlation in ridge gourd, *Horticultural Journal*,**15(3):** 53-58.

Cutler, H. C., and T. W. Whitaker (1967). Cucurbits from the Tehuacan caves, In: *Prehistory of the Tehucan Valley*, (Eds. D.S. Byers), 212-219. University of Texas Press, Austin, Texas, USA.

Fisher, R. A. (1918) Correlations between relatives on the supposition of Mendelian inheritance. *Trans Royal Society. Edenburg* **52**: 399-433.

Fisher, R. A. and Yates, F. 1936. Statistical tables for biological, agricultural and medical research, 5 aufl. oliver and boyd. edinburg

Johansen, W.L. (1909) Elements der exakten Erblickkeits. *Fischer verlag*, Jena.

Lush, J. L. (1949). Heritability of quantitative traits in farm animals. Proc. 8thInt. Cong. Genetics 1948. *Heridos* (Supp) 336-357.

Mahalanobis, P. C. (1936). On the generalized distance in statistics. *Proc. Nat. Inst. Sci. India*.12-49.

Murty, B. R. and Arunanchalam, V. (1966) The nature of genetic divergence in relation to breeding system in crop plants. *Journal of Genetics*, **26**: 188-198.

Panse, V. G. and Sukhatme, P. V. (1967). Statistical methods for Agricultural workers, Indian Council of agriculture Research, New Delhi.252-254.

Rao, C. R. (1952). Advanced statistical methods in biometrical research. Edn. I. John Wiley and Sons, Inc. New York.

Sivasubramanian J. and Madhavamenon P. (1973). Genotypic and phenotypic variability in rice. *Madras Agric. J.* **12:** 15-16.

Webber, C. R., and Moorthy, B. R. (1952). Heritable and non-heritable relationship and variability of oil content and agronomic characteristics in the F generation of soybean crosses. *Journal of Agronomy*, **44**: 202-209.

Yadav, A., Tandan, N. and Singh, R. (2017) Morphological based genetic variability analysis and clustering of tomato**.** *wjpmr*, **3(6),** 255-261