Original Research Article

Studies on genetic variability, correlation analysis in Mithipagal (*Momordica charantia* var. *muricata*) genotypes

Abstract

The present investigation was carried out in Tamilnadu Agricultural University, Coimbatore to study the “Genetic variability and correlation analysis in Mithipagal (*Momordica charantia* var. *muricata*) genotypes”. Observations on vine length, days to male flower inflorescence, days to female flower inflorescence, node of first male flower appearance, node of first female flower appearance, sex ratio, number of fruits per vine, fruit weight, fruit length, fruit girth, number of seeds per fruit, yield per vine, ascorbic acid, protein content, iron content and total soluble solids were recorded. Variability and correlation analysis among genotypes were examined. The results, showed that yield per plant had high positive and high significant correlation with fruit weight, fruit girth, number of seeds per fruit, vine length and fruit length. High genotypic co-efficients of variation (GCV) were found for fruit yield per vine, fruit weight, TSS, fruit length, vine length, fruit girth, node of first female flower, number of fruits per vine, number of seeds per fruit, iron, protein content when genetic characteristics were taken into account, However low GCV was found for days to the first male and female flowering. Phenotypic variants were always greater than genotypic variances. For traits such asyield per vine, fruit weight, TSS, fruit length, vine length, fruit girth, number of fruits per vine, number of. seeds per fruit, node of first male flower appearance, node of first female flower appearance, sex ratio, vitamin C, protein, iron content high heritability was found together with high genetic advance in percent of mean, indicating that these features are under additive gene control and hence selection for genetic improvement would be successful. Node of first male flower appearance showed low heritability combined with low genetic advance as a percentage of the mean indicating that non-additive gene effects were involved in the expression of this trait and hence selection for such a trait could not be beneficial. The knowledge of these statistical factors would be useful in

identifying genotypes with greater yield potential that might be used in the improvement of mithipagal.

Key word: Mithipagal, Yield, Correlation, Genetic variability, Heritability, Genetic advance

INTRODUCTION

"Vegetables are an essential part of the human diet because they include vitamins and minerals that are essential to our metabolic processes. After China, India is the world's second largest producer of vegetables. Because of the country's diverse topography and climate, vegetables are available throughout the year. Recent years have seen a rise in the popularity of wild edible forms as crops due to their therapeutic and nutritional benefits (Flyman and Afolayan, 2007; Jiji, 2014; Naik*et al*., 2017), as well as their capacity to withstand biotic and abiotic challenges (Asna *et al*., 2018; Sharma *et al*., 2018).

The family Cucurbitaceae, comprises some of the most significant vegetables in the world that are used for salads, pickles (cucumber), cooking, candy making or preservation (ash gourd), or as dessert fruits (musk melon and water melon), pumpkin and squash, and bitter gourd, has over 965 species divided into 95 genera. Plants in this family are grown in the tropics and temperate zones, and those with edible fruits were among the first to be cultivated in both the Old and New Worlds.

Momordica charantia var. *muricata* is recognized as the bitter gourd's progenitor species (Degner 1947; Chakravarty, 1982; Joseph and Antony, 2009; Joseph and Antony, 2010**)** which is an underutilized vegetable grows well in tropical and subtropical climates.It is a wild kind of bitter gourd that is grown throughout Tamil Nadu, Kerala and Southern states of India. It is also called as mithipagal, neripagal, kaippanpaval, undapaval, sirupavakaai, chinnapavai, rudrakshahagali, nadanpaval, chickuhagali, karandakapaval, kuttathipaval, kaipanpaval, kaduhagali *etc.* It contains vital elements like vitamins (such vitamin C and A), minerals (like potassium and magnesium), and dietary fiber. It is a monoecious annual climber and has unbranched glabrous tendrils. Since it is a herbaceous vine, pandal is not necessary. On the ground, it can reach a length of 1.5 metres. June to September is the time for flowering and fruiting. The species should be conserved because it is used in traditional medicine for its various potential health benefits. It is believed to have anti-diabetic properties, as it may help lower blood sugar levels. Additionally, it is thought to possess antioxidant, anti-inflammatory, and antimicrobial properties. Tamil Nadu cultivates it due to its good taste and texture when cooked.

Materials and Methods

Plant materials and experimental design

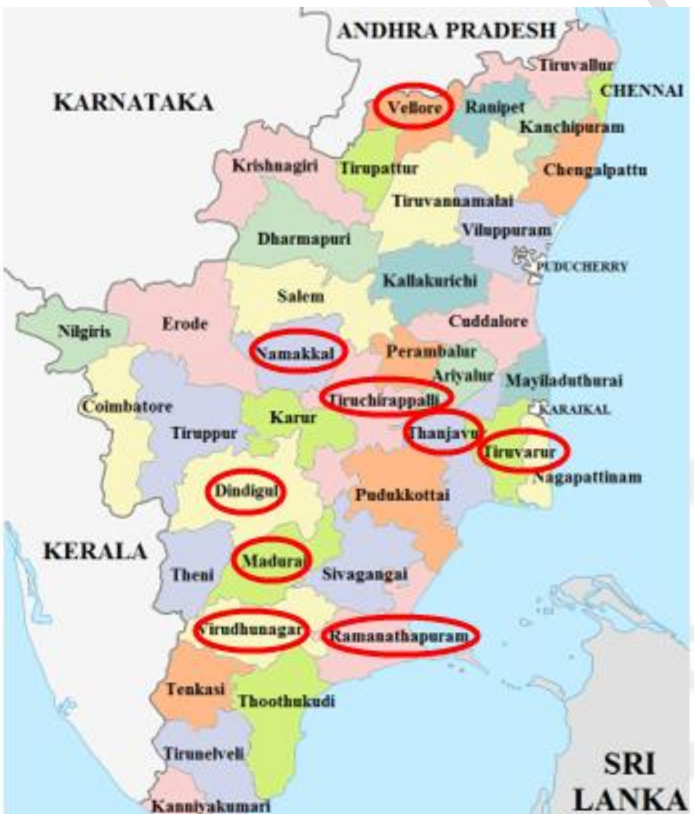

Fig. 1. ***Mithipagal*** *Genotypes collected from above encircled districts of Tamil Nadu*

The current study on mithipagal (*Momordica charantia* var. *muricata*) evaluation was carried out at the Horticultural College and Research Institute, TNAU, Coimbatore. In Tamil Nadu, twenty genotypes of mithipagal were collected from Thanjavur, Dindugal, Virudhunagar, Trichy, Ramnad, Namakkal, Thiruvarur, Vellore, and Madurai districts.

These genotypes were grown in Randomized Block Design and were replicated twice, with spacing of 2x2 m apart. The experimental plot was ploughed and fine tilled. To improve germination, the seeds were soaked in cowdung for 12 hours before sowing. Each pit were sown with two or three seeds and pits were spaced at a distance of two meters in a row. Following germination, the plants were thinned to one seedling per hill. The cultural operations and plant protection measures were carried out in accordance with the package of practices recommended by TNAU for bittergourd, which required 20 tonnes of FYM / ha recommended dose of basal fertilizer (6:12:12 g of NPK/plant). Vine length, days to first male flower inflorescence, days to first female flower inflorescence, node of first male flower appearance, node of first female flower appearance, sex ratio, number of fruits per vine, fruit weight, fruit length, fruit girth, number of seeds per fruit, yield per vine, TSS, ascorbic acid, iron content and protein content were all observed and recorded. Heritability and genetic progress were estimated in accordance with following formula:

$$\text{Heritability (Broad sense)} = \frac{Genotypic\ \ variance}{Phenotypic\ \ variance} \times 100$$

As suggested by (Johnson et al. 1955), heritability values are categorized as follows:

Low: Less than 30%

Moderate: 30-60%

High: More than 60%

The genotypic and phenotypic coefficients of variability were determined in accordance with Burton and De-Vane (1953).

Phenotypic coefficient of variation and genotypic coefficient of variation:

$$\textbf{PCV} = \frac{\sqrt{Phenotypic\ \ variance}}{Mean} \text{x100}$$

$$\textbf{GCV} = \frac{\sqrt{Genitypic\ \ variance}}{Mean} \text{ x 100}$$

According to the formula provided by Al-Jibouri *et al.,* (1958), the phenotypic and genotypic correlation co-efficient for fruit production were calculated. The statistical software TNAU STAT was used to perform all calculations.

- Phenotypic Correlation (rp) = PCOV xy/ (PVx. PVy)$^{1/2}$
- Genotypic Correlation (rg) = GCOV xy/ (GVx. GVy)$^{1/2}$

Table.1 Details and sources of mithipagal genotypes

Genotypes	Source	Genotypes	Source
MCM 1	Ananthalai local	**MCM 11**	Ramnad local
MCM 2	Kaveripakkam local	**MCM 12**	Namakkal local
MCM 3	Thiruvarur local	**MCM 13**	Aruppukottai local
MCM 4	Peravurani local	**MCM 14**	Chengalpattu local
MCM 5	Arugundram local	**MCM 15**	Thiruneermalai local
MCM 6	Madurai local	**MCM 16**	Mutharasanallur local
MCM 7	Dindugal local	**MCM 17**	Gyapuram local
MCM 8	Virudhunagar local	**MCM 18**	Sivakasi local
MCM 9	Solamadhevi local	**MCM 19**	Appanur local
MCM 10	Sathur local	**MCM 20**	Pattukotai local

Result and discussion

Genotypic correlation coefficient between different characters of mithipagal genotypes

Genotypic correlation coefficient computed for twenty genotypes under this study (Table 2) for the characters of fruit weight, fruit girth, the number of seeds per fruit, vine length, and fruit length showed highly significant and positive genotypic correlations with yield per vine and these reports are in agreement with the findings of Priyanka *et al.,* (2018). Fruit weight is positively correlated with yield and this findings was supported by Ram *et al*., (2006) in bitter gourd and Ritu Panday *et al*., (2006) in sponge gourd. Vitamin C showed a substantial positive genotypic correlation with yield per vine. The interrelationships between the yield's component characters may provide the most probable results of selection for concurrent improvement of desirable characters. Days to first male flower inflorescence, days to first female flower inflorescence and node of first female flower appearance showed highly and negative association between yield and this is similar to the findings of Yadav *et al*., (2013) and Islam *et al*., (2009) in bitter gourd.

Vine length exhibited a highly significant and positive association with fruit weight, fruit length, fruit girth, number of seeds per fruit, yield per vine and these are in agreement with findings of Saranyadevi *et al*., (2017) in mithipagal. Vine length had negative significant correlations with days to first male flower inflorescence, days to first female flower inflorescence in accordance with Janaranjani *et al.* (2015) in bottle gourd.

Days to first male flower inflorescence exhibited high significant and positive correlation with days to first female flower inflorescence and this findings are in agreement with Priyanka *et al*. (2018) in mithipagal. Days to first female flower appearance had a highly significant and favorable relationship with node of first female flower appearance, which was supported by Haque et al. (2013). Fruit weight exhibited highly significant and positively association with fruit length, (Ahmed *et al*., 2005) and also fruit girth, number of seeds per fruit, vitamin C and yield per vine. The fruit weight had negative and non significant association with fruit number per vine, which was in agreement with Ram *et al*., (2006). Fruit length exhibited highly significant and positive association with fruit girth, number of seeds per fruit, vitamin C and yield per vine. Fruit girth exhibited highly significant and positive correlation with number of seeds per fruit and yield per vine.

Characters that exhibited a favorable and significant relationship with yield and inter correlated would be desirable in a breeding program aimed at improving multiple traits simultaneously. Thus, exercising selection for these traits in the high yielding genotypes would bring elite single plant selections in identification and release of a new improved variety in future.

Phenotypic and Genotypic coefficient of variation

For all of the qualities assessed in the current analysis, a larger phenotypic coefficient of variation was found in comparison to its corresponding genotypic coefficient of variation. For all of the features under consideration, only marginal differences were found between these two coefficient variations. It also stated that selection might be successfully done based on phenotypic performance and that genetic factors are primarily responsible for the expression of those qualities. Deshmukh *et al.* (1986) defined PCV and GCV values as high if they are greater than 20 per cent, low if they are less than 10 per cent, and medium if they are between 10 per cent and 20 per cent.

In terms of fruit yield per vine, fruit weight, TSS, fruit length, vine length, fruit girth, node of first female flower inflorescence, number of fruits per vine, number of seeds per fruit, Iron, protein the highest genotypic and phenotypic coefficients of variation were found. Node of first male flower appearance and sex ratio and vitamin C however, showed moderate GCV and PCV, while the remaining characters such as the days to first male flower inflorescence and days to first female flower inflorescence showed low GCV and PCV. GCV and PCV values that were lower than average indicating their limited potential for improvement.

Genetic advance

Genetic advance is the inherited improvement of the progeny above the original population brought about through selection, and it aids in the evaluation of the selection processes. Because of the characters environment masking effects, the worth of genetic advance fluctuated greatly. Therefore, genetic advance as a percent mean was calculated to anticipate the genetic gain (Table 3) in order to achieve relative comparison of the features in connection to the environment.

Heritability

"High heritability coupled with low genetic advance, low heritability with high genetic advance or low heritability and low genetic advance offers less scope for selection because of non-additive genetic effects. High heritability coupled with high genetic advance showed greater proportion of additive genetic variance and consequence a high genetic gain expected from selection" (Devi and Mariappan, 2013). "The characters having heritability with low genetic advance as percent of mean appeared to be controlled by non-additive gene action and selection for such characters may not be effective" (Singh and Singh, 2007). Heritability values were found to be high for most of the characters.

Characteristics such as vine length, days of first female flower inflorescence, days of first male flower inflorescence, node of first female flower, sex ratio (M/F), number of fruits per vine, fruit weight(g), fruit girth(cm), number of seeds per fruit, vitamin C, iron, TSS, protein, yield per vine were found to have high heritability along with high genetic advances. The findings suggest that these features have larger selection responses and that these traits are controlled by additive gene activities. The findings are in accordance with the reports of Pathak *et al*., (2014) in bittergourd. Node of first male flower appearance were showed low heritability combined with low genetic advance as a percentage of the mean. It is reasonable to believe that non-additive gene activity controls this feature and selection for such traits are not rewarding. Instead of the genotype, the environment is having a positive influence on the heritability, hence simple selection will not be effective. However, this can be enhanced by the creation of hybrids or the use of transgressive segregants in heterosis breeding programs.

Conclusion

From this study it is concluded that in the breeding programme directed towards improving many traits simultaneously, characters showing positive and significant correlation with yield and between them would be considered desirable. The traits like fruit weight, fruit girth, number of seeds per fruit, vine length, and fruit length results in simultaneous enhancement of fruit yield per vine and also inter-correlated among themselves. The highest genotypic and phenotypic coefficients of variation were found in fruit yield per vine, fruit weight, TSS, fruit length, vine length, fruit girth, node of first female flower inflorescence, number of fruits per vine, number of seeds per fruit, iron and protein contents. The highest heritability with high genetic advance was found in as yield per vine, fruit weight, TSS, fruit length, vine length, fruit girth, number of fruits per vine, number of seeds per fruit, node of first male flower appearance, node of first female flower appearance, sex ratio, vitamin C, protein and iron content. Moreover, it is evident that these traits are very dependable predictors of fruit production and may be used as yield markers in selection process

Table 2. Genotypic correlation coefficients between different characters of mithipagal genotypes

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16
X1	1	-0.683**	-0.766**	0.006^{NS}	-0.466**	-0.071^{NS}	-0.034^{NS}	0.727**	0.443**	0.543**	0.685**	0.358*	-0.267^{NS}	-0.024^{NS}	-0.083^{NS}	0.759**
X2		1	0.712**	0.164^{NS}	0.397*	0.080^{NS}	0.044^{NS}	-0.581**	-0.383*	-0.599**	-0.474**	-0.030^{NS}	0.262^{NS}	-0.037^{NS}	0.079^{NS}	-0.575**
X3			1	0.339*	0.471**	-0.064^{NS}	0.061^{NS}	-0.722**	-0.715**	-0.713**	-0.660**	-0.331*	0.066^{NS}	-0.074^{NS}	0.113^{NS}	-0.712**
X4				1	-0.124^{NS}	-0.371*	-0.145^{NS}	0.229^{NS}	0.052^{NS}	0.163^{NS}	0.086^{NS}	0.015^{NS}	-0.132^{NS}	-0.427**	0.302^{NS}	0.213^{NS}
X5					1	0.225^{NS}	-0.033^{NS}	-0.547**	-0.378*	-0.468**	-0.501**	-0.169^{NS}	-0.192^{NS}	-0.067^{NS}	-0.013^{NS}	-0.592**
X6						1	0.160^{NS}	-0.040^{NS}	0.179^{NS}	-0.019^{NS}	0.082^{NS}	0.022^{NS}	-0.147^{NS}	0.353*	-0.247^{NS}	-0.088^{NS}
X7							1	-0.294^{NS}	-0.473**	-0.231^{NS}	-0.309^{NS}	-0.172^{NS}	0.344*	0.220^{NS}	0.226^{NS}	0.121^{NS}
X8								1	0.894**	0.902**	0.911**	0.484**	-0.154^{NS}	-0.029^{NS}	0.115^{NS}	0.902**
X9									1	0.848**	0.818**	0.453**	-0.119^{NS}	0.006^{NS}	-0.023^{NS}	0.673**
X10										1	0.788**	0.375*	-0.117^{NS}	-0.075^{NS}	0.189^{NS}	0.802**
X11											1	0.517**	-0.102^{NS}	0.222^{NS}	0.139^{NS}	0.774**

X12												1	-0.123^{NS}	0.450**	0.370*	0.379*
X13													1	0.175^{NS}	0.379*	0.005^{NS}
X14														1	0.080^{NS}	-0.031^{NS}
X15															1	0.199^{NS}
X16																1

X1 - Vine length(m)
X2 -Days to first male flower inflorescence
X3 -Days to first female flower inflorescence
X4 -Node to first male flower appearance
X5 -Node to first male flower appearance
X6 -Sex ratio(M/F)
X7 -No. of. Fruits per vine
X8 -Fruit weight (gm)

X9 – Fruit length (cm)
X10 – Fruit girth (cm)
X11 – No. of. Seeds per fruit
X12 - Vitamin C (mg/100gm)
X13 - Iron (mg/100gm)
X14 - TSS (Brix)
X15 - Protein (mg/100gm)
X16 – Yield per vine (Kg/vine)

Table 3. Genotypic and phenotypic coefficient of variation, heritability and genetic advance as per cent mean of mithipagal genotypes

Parameters	Heritability %	Genotypic Coefficient of Variations	Phenotypic Coefficient of Variations	Genetic Advance	Genetic Advance value % means
Vine length	78.93	27.72	31.2	0.88	50.73
Days to first male flower appearance	92.61	8.16	10.08	4.97	19.23
Days to first female flower appearance	88.76	7.82	9.7	6.52	17.73
Node of first male flower	36.016	10.5	17.5	0.64	12.98
Node of first female flower	69.59	20.81	24.94	5.32	35.76
Sex ratio (M/F)	89.84	18.12	19.11	8.56	35.38
No. of. fruits per vine	80.9	21.38	23.77	11.49	39.61
Fruit weight(g)	75.34	48.78	56.2	7.3	87.23
Fruit length (cm)	56.51	31.86	42.38	2.1	49.34
Fruit girth(cm)	75.59	27.71	31.42	3.21	48.93
No. of. seeds per fruit	83.68	25.08	27.42	4.21	47.27
Vitamin C	99.91	12.55	12.55	25.32	25.85
Iron	95.75	44.19	45.15	3.03	89.08
TSS	98.62	28.67	28.87	1.46	58.66
Protein	98.81	29.14	29.31	1.69	59.67
Yield	79.9	52.59	58.83	0.21	96.84

References

1. Ahmed, N., Hakeem, Z. A., Singh, A. K., & Afroza, B. (2005). Correlation and path coefficient analysis in bottle gourd. *Haryana Journal of Horticultural Sciences*, *34*(1/2), 104.
2. Al-Jibouri, H., Miller, P. A., & Robinson, H. F. (1958). Genotypic and environmental variances and covariances in an upland Cotton cross of interspecific origin 1. *Agronomy journal*, *50*(10), 633-636.
3. Asna, A. C. (2018). Characterization and distant hybridization for biotic stress tolerance in bitter gourd (*Momordica charantia* L.).
4. Burton, G. W., & Devane, D. E. (1953). Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material 1. *Agronomy journal*, *45*(10), 478-481.
5. Chakravarty, H. L. (1990). "The development of vegetable crops". *Biology and Utilization of the Cucurbitaceae*, *325*.
6. Deshmukh, S. N., Basu, M. S., & Reddy, P. S. (1986). Genetic variability, character association and path coefficients of quantitative traits in Virginia bunch varieties of groundnut. *Indian Journal of Agricultural Science*, *56*(12), 816-821.
7. Devi, N. D., & Mariappan, S. (2013). Genetic variability, heritability and genetic advance for yield and its components snake gourd (*Trichosanthes anguina* L.). *African Journal of Agricultural Research*, *8*(28), 3857-3859.
8. Haque, M. M., Uddin, M. S., Mehraj, H., & Jamal Uddin, A. F. M. (2014). Evaluation of snake gourd (*Trichasanthes anguina* L) test hybrids comparing with four popular checks. *International Journal of Applied Sciences and Biotechnology*, *2*(4), 525-528.
9. Islam, M. R., Hossain, M. S., Bhuiyan, M. S. R., Husna, A., & Syed, M. A. (2009). Genetic variability and path-coefficient analysis of bitter gourd (*Momordica charantia* L.). *Int. J. Sustainable Agric*, *1*(3), 53-57.
10. Janaranjani, K. G., Kanthaswamy, V., & Kumar, S. R. (2016). Heterosis, combining ability, and character association in bottle gourd for yield attributes. *International Journal of Vegetable Science*, *22*(5), 490-515.

11. John, K. J., & Antony, V. T. (2010). A taxonomic revision of the genus *Momordica* L.(Cucurbitaceae) in India. *Indian Journal of Plant Genetic Resources*, *23*(2), 172-184.
12. Johnson, H. W., Robinson, H. F., & Comstock, R. E. (1955). Genotypic and phenotypic correlations in soybeans and their implications in selection 1. *Agronomy journal*, *47*(10), 477-483.
13. Pandey, R., Singh, D. K., & Upadhyay, M. (2006). Study of correlation and path coefficient under different seasons in sponge Gourd (*Luffa cylindrica* Roem.). *PROGRESSIVE HORTICULTURE*, *38*(2), 224.
14. Pathak, M., & Pahwa, K. (2014). Genetic variability, correlation and path coefficient analysis in bittergourd (*Momordica charantia* L.). *International Journal of Advanced Research*, (AVRDC Staff Publication).
15. Priyanka, M. (2018). Correlation and path analysis studies in Mithipagal (*Momordica charantia* L var. *muricata*)(Willd.). *Electronic Journal of Plant Breeding*, *9*(3), 1213-1220.
16. Ram, D., Rai, M., Singh, H. K., Verma, A., Pandey, S., & Kumar, A. (2006). Cause and effect analysis of yield in off-season bitter gourd (*Momordica charantia* L.).
17. Rani, K. R., Raju, C. S., & Reddy, K. R. (2015). Variability, correlation and path analysis studies in bitter gourd (*Momordica charantia* L.). *Agricultural Science Digest-A Research Journal*, *35*(2), 106-110.
18. Saranyadevi, G., Lakshmanan, V., & Rohini, N. (2017). Performance evaluation and correlation analysis in mithipagal genotypes (*Momordica charantia* var. *muricata*). *Electronic Journal of Plant Breeding*, *8*(2), 652-659.
19. Singh, M., Kumar, K., & Singh, R. P. (2007). Study of coefficient of variation, heritability and genetic advance in hybrid rice. *ORYZA-An International Journal on Rice*, *44*(2), 160-162.
20. Suma, A., Alfia, M. A., John, K. J., Pradheep, K., Harish, G. D., Thirumalaisamy, P. P., & Latha, M. (2023). On the development of descriptors in small bitter gourd (*Momordica charantia* L. var. *muricata* (Willd.) Chakrav). *Genetic Resources and Crop Evolution*, *70*(1), 289-308.

21. Veena, R., Sidhu, A. S., Pitchaimuthu, M., & Souravi, K. (2013). Character association for fruit yield and yield traits in Cucumber (*Cucumis sativus* L.). *Electronic Journal of Plant Breeding*, *4*(1), 1108-1112.

22. Yadav, M., Pandey, T. K., Singh, D. B., & Singh, G. K. (2013). Genetic variability, correlation coefficient and path analysis in bitter gourd. *Indian Journal of Horticulture*, *70*(1), 144-149.