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Research Note

Performance evaluation and correlation analysis in mithipagal genotypes (*Momordica charantia* var. *muricata*)

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Abstract
The evaluation of twenty genotypes of mithipagal was carried out under Periyakulam condition. Observation were recorded for the following traits *viz*, vine length, days to male flower appearance, days to female flower appearance, nodes of male flower appearance, nodes of female flower appearance, sex ratio, fruits per vine, fruit weight, fruit length, fruit girth, fruit thickness, seeds per fruit, yield per vine, ascorbic acid, momordicine content, protein content and total soluble solids. Among the genotypes, MC 7 (0.64 kg) followed by MC 20 (0.62 kg) and MC16 (0.53 kg) recorded the highest mean value of fruit yield. Correlation analysis revealed that fruit yield per vine was significant and positively correlated with vine length, nodes of female flower appearance, fruits per vine, fruit length, fruit girth, fruit weight, fruit thickness, seeds per fruit, momordicine content and protein content. However negative association was observed with days to first male flower appearance, days to first female flower appearance and nodes of first male flower appearance. Hence selecting mithipagal genotypes with high fruit weight, more number of fruits per vine and seeds per fruit, fruits with high flesh thickness and momordicine and protein content will help to improve yield per vine and quality of mithipagal fruits.

Key words
Evaluation, mithipagal, association analysis, yield, quality

Cucurbitaceae family has about 90 genera and over 700 species of economic importance and it includes several of the World's most important vegetables *viz*., melon (*Cucumis melo*), cucumber, watermelon, pumpkin and squash, and bitter gourd. Mithipagal (*Momordica charantia* L. var. *muricata* (Willd.), Chakravarty (1985), Joseph and Antony (2010) reported that this cucurbitaceous vegetable crop is globally distributed in Tropical countries. It is a wild type of bitter gourd cultivated in all the districts of Tamil Nadu and Kerala. It is called as mithipagal, neri pagal, kaippanpaval, undapaval and siru pavakaai.

Mithipagal is an important vegetable crop grown for its fleshy fruits in tropical and subtropical regions. As the name signifies, the fruits are bitter in taste. The bitter principle in bitter gourd is momordicine, an alkaloid, which is different from cucurbitacins present in other cucurbits. It has several uses. The fruits are used as vegetables in many ways and quite commonly used in cooked, fried and stuffed forms. Tamil Nadu has rich gene pool in mithipagal as a wild type, as well as in homestead garden. It has a vast scope for growing in marginal lands where it gives fruits throughout the year. However, mithipagal is gaining popularity among the consumers and producers due to its nutritive or medicinal value and round the year production potential. Owing to non availability of standard varieties, the farmers are cultivating only landraces which have low yield potential with variable fruits.

One of the primary objectives of any crop improvement programme is the identification of promising genotypes by exploiting variability within the species through a proper breeding strategy. Such a study helps to locate the desirable types and for further utilization of the selected types in the improvement programme. Therefore, an attempt was made to estimate the fascinating array of variability and scope for improvement of important characters among twenty genotypes collected from diverse sources with a view to select high yielding type with appreciable fruit quality traits.

Further, the yield of crop depends upon number of component characters; consideration on yield determinants simultaneously will be helpful in improving the efficacy of selection. Keeping this in view, the present investigation was carried out with an objective of selecting high yielding types of mithipagal to determine the interrelationship of biometrical and biochemical characters contributing to yield and quality characters of mithipagal.

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The present investigation on evaluation of mithipagal (*Momordica charantia* var. *muricata*) was conducted during September 2012 to August 2013 at Western block, Horticultural College and Research Institute, Periyakulam. Twenty genotypes of mithipagal collected from Virudhunagar, Tuticorin, Ramnathapuram and Tanjore districts in Tamil Nadu. Details of the genotypes are furnished in table 1. These genotypes are raised in randomized block design block replicated twice with twenty plants in each replication following a spacing of 1 x1 m. The experimental plot was ploughed and brought to

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fine tilth. Before sowing, the seed were soaked in water for 12 hours to improve germination. Two or three seeds of each seedling per hill were dibbled at distance of one meter in a row. The plants were thinned to one seedling per hill after germination. 20 tonnes of FYM / ha recommended dose of basal fertilizer (6:12:12 g of NPK/plant) required, the cultural operations and plant protection measures were followed as per the package of practices recommended by TNAU for bitter gourd. Observation were recorded on vine length , days to first male flower appearance, days to first female flower appearance, node of first male flower, node of first female flower, sex ratio, number of fruits per vine, individual fruit weight, fruit length, fruit girth, number of seeds per fruit, fruit pulp thickness, yield per plant, TSS, ascorbic acid, iron content, momordicine content. The data were subjected to statistical analysis to obtain mean performance (Panse and Sukhatme, 1957). Correlation co-efficients for yield and other traits in all seven genotypes were worked out as suggested by Johnson *et al.* (1955).

In a selection programme, mean performance serves as a primary criterion. The variability in a population with respect to characters is an indispensable, pre-requisite for a successful breeding programme. Information obtained from mean performance will be helpful in identifying outstanding genotypes. Hence, twenty mithipagal genotypes were evaluated for growth and yield attributes (Table 2). Vine length is an important yield component by which growth and vigour of plants are measured. The vine length was high in MC-20 (2.65m) followed by MC-14 (2.54 m), MC-5 (2.36 m) and MC-16 (2.13 m). Similar trend of variation was also reported by Jadhav *et al*. (2009) in bitter gourd. Earliness is one of the main attributes which is measured in terms of days to first male and female flower appearance and it could be the accumulation of favourable genes. The genotypes MC-18 (20.66), MC-16 (21.215) and MC-19 (22.55) exhibited earliness by producing male flowers in shortest duration. The genotypes MC-6 (30.33), MC-15 (30.35), MC-19 (30.95) were exhibiting earliness in case of first female flower appearance. This was also in line with the findings of Sundaram (2006) and Jadhav *et al*. (2009) in bitter gourd.

Node of first male and female flower is one of the measures for earliness. The genotype MC-2 (4.02), MC-5 (4.05) and MC-8 (4.10) produced male flowers at the early nodes, where as MC-2 (7.50), MC-3 (8.58), MC-7 (9.60), MC-14 (9.78) and MC-6 (10.00) exhibited earliness by producing female flowers at the earlier nodes. This was also in conformity to the report of Thangamani (2008) in bitter gourd. Estimation of sex ratio is highly essential for cucurbits which indicate the ability of the crop to set fruits. Low sex ratio is the favourable trait in cucurbits. In present study the genotype MC-15 (17.99), MC-2 (18.83), MC-8 (18.93) and MC-12 (19.50) had the lower sex ratio. Number of fruits, fruit length and fruit diameter together form the most important closely related productivity parameters. Higher the fruit number more will be the yield, in this study, the accession, MC-5 (38.91), MC-6 (35.50), MC-14 (35.30) and MC-15 (33.69) were producing higher number of fruits per vine. The genotype, MC-20 (11.60° Brix), MC-8 (8.59° Brix) and MC-4 (8.93° Brix) registered high total soluble solids. Similarly, Ratna Prabha *et al*. (2007) reported earlier node number for first female flower production, higher fruit number per vine and high total soluble solids in the line PHS 10 of ridge gourd genotype.

In case of fruit length, the genotype MC-20 (11.60 cm), MC-2 (8.50 cm) and MC-11 (7.63 cm) recorded higher values and fruit weight also contributes to higher yield. Among the twenty genotypes MC-20 (24.10g), MC-7(18.20 g), MC-16 (12.55 g) and MC-11 (12.80g) recorded higher fruit weight, where as MC-11(14.17 cm) and MC-20 (13.83 cm) recorded higher values of fruit girth. Flesh thickness is an interrelated character, which determines the market preference. The present study revealed the genotypes MC-20 (4.71 mm), MC-19 (3.95 mm) and MC-7 (3.88 mm) possessed favourable values for this trait. This was also in conformity to the report of his findings of Thangamani (2008) in bitter gourd.

Ascorbic acid is a nutritionally important character and higher contents were observed in the genotypes MC-20 (120.83 mg/100g), MC-14 (118.66 mg/100g) and MC-5 (113.29 mg/100g). Protein content also an important parameter, the genotypes MC-20 (3.77 mg/100g), MC-5(3.34 mg/100g) and MC-18 (3.33 mg/100g) registered higher magnitudes of protein content. Similar trend of result was reported by Assubaie (2004), Dey (2006) and Priyadharshini (2011). Momordicine is an important alkaloid present in the mithipagal. In the present study the genotype MC-18 (3.61 mg/g), MC-19 (3.24 mg/g) and MC-20 (3.12 mg/g) recorded higher magnitudes of momordicine content. This was also in conformity to findings of Thangamani (2008) in bitter gourd. The evaluation among genotypes in the present study, thus led to the identification of MC-20, MC-16, MC- 7, MC-14 and MC-2 as potential genotypes for the future utilization.

Correlation analysis: The ultimate goal of crop improvement in mithipagal is to achieve a higher level of fruit yield. Being a complex trait, the fruit yield is largely influenced by many component characters. So information on strength and direction of correlation of these component characters on fruit yield and inter association among them would be useful in designing breeding

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programmes for yield improvement. The relationship between yield and its component characters is likely to vary according to the genetic material used, environment under which the material is evaluated as well as due to interaction of these factors. Therefore it is worthwhile to study the heritable association between variables (genotypic correlation) for identification of important yield components so that due weightage can be given to the characters of importance in further selection programme. (Johnson *et al*.,1955).

In the present investigation, genotypic correlation coefficient was higher than the phenotypic correlation coefficient thus revealing a strong association at genotypic level between the characters. The genotypic coefficient of variation worked out among different characters with fruit yield revealed that, out of 17 characters studied, 13 characters *viz*., vine length (m), nodes for first female flower appearance, sex ratio, number of fruit per vine, number of fruit per vine, fruit length (cm), fruit girth (cm), number of seeds per fruit, fruit thickness (mm), TSS (ºBrix), vitamin-C (mg per 100g), protein, momordicine content (g per 100g) recorded positive and significant association with fruit yield (Table 3). Days to first male flower appearance, days to first female flower appearance, node of first male flower appearance recorded negative and significant association with fruit yield. This is also similar to the findings of Yadav *et al*. (2013), Islam *et al*. (2009) in bitter gourd, Hossain *et al*. (2010) in cucumber. Similarly positive association of fruit weight with fruit yield observed in the present study is in affirmation with the works of Ram *et al*. (2006) in bitter gourd and Ritu Panday *et al*. (2006) in sponge gourd.

The inter association of component characters for yield may provide the likely consequences of selection for simultaneous improvement of desirable characters. The inter correlation of days to first female flower appearance with yield revealed negative association. (Saroj Rolania *et al*., 2003). In current study, vine length had positive and highly significant association with days to first female flower appearance (Saroj Rolania *et al*., 2003). The days to first female flower appearance had negative and non significant association with fruit number per vine (Ritu Pandey *et al*., 2006). Number of nodes per vine had negative and significant correlation with days to first appearance of male flower (Yadhav *et al.,* 2013).

Days to first appearance of male flower showed significant and negative correlation with number of fruits per vine. Significant and positive correlation for nodes of first flower appearance was recorded with fruit length (Yadhav *et al.,* 2013). The fruit weight had negative and non significant association with fruit number per vine, which was in agreement with Ram *et al*. (2006). The fruit weight had positive and highly significant association with fruit length (Ahmed *et al*., 2005). Whereas, fruit length had negative and non significant association with fruit number per vine (Ritu Pandey *et al*., 2006). Highly positive significant correlation was noticed for fruit length (cm) both at genotypic and phenotypic level which positively correlated on yield per plant. Strong significant positive correlations were noted for vine length (m) at genotypic parameters level weight per fruit (g) both at genotypic and phenotypic level (Islam *et al*., (2009).

The characters such as vine length, days to first harvest, fruit weight, fruit girth and seeds per fruit showed significant correlation with yield and also had significant correlation among themselves. Among the 17 traits studied, the days to first female flower appearance showed negative but significant correlation with yield and other traits. Whereas except days to first female flower appearance, other characters have registered positive and significant correlation with yield and other traits.

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. In the present study, the correlation and inter correlations highlighted the prominent role of certain traits such as vine length, days to first harvest, fruit weight, fruit girth and number of seeds per fruit. Thus, it can be concluded that exercising selection for these traits in the top ranking five genotypes *viz*., MC-20, MC-16, MC-7, MC-14 and MC-2 would bring elite single plant selections in identification and release of a new improved variety in future.

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Table 1. Details and source of genotypes

Genotypes	Source	Genotypes	Source
MC -1	Kovilpatti local	MC -11	Gandhinagar local
MC -2	Srivilliputhur local 1	MC -12	Kattuparamakudi local
MC -3	Sathur local	MC -13	Emaneeswaram local
MC -4	Krishnankovil local	MC -14	Periyakulam local 1
MC -5	Watrap local	MC -15	Periyakulam local 2
MC -6	Virudhunagar local	MC -16	Periyakulam local 3
MC -7	Thalaivaipuram local	MC -17	Periyakulam local 4
MC -8	Sevalore local	MC -18	Dindigul local
MC -9	Thirumakottai local	MC -19	Theni local
MC -10	Kattuthottam local	MC -20	Srivilliputhur local 2

MC - Momordica charantia

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Table 2. Mean performance for mithipagal genotypes for yield and quality

Genotypes	Vine length (m)	Days to first male flower appearance	Days to first female flower appearance	Nodes of first male flower appearance	Nodes of first female flower appearance	Sex ratio (M/F)	Number of fruits per vine	Individual fruit weight (g)	Fruit length (cm)	Fruit girth (cm)
MC -1	1.48	30.21	39.00	7.08	12.00	23.16	21.66	3.20	4.12	4.55
MC -2	0.98	24.01	36.33	4.02	7.50	18.83	20.35	12.25	8.50	12.23
MC -3	1.00	29.76	40.50	5.20	8.58	21.99	32.80	5.10	5.81	7.45
MC -4	1.45	25.85	34.16	6.40	12.73	25.33	27.95	5.32	5.71	7.82
MC -5	2.36	26.49	33.66	4.05	12.70	22.66	38.91	2.35	3.49	4.57
MC -6	1.32	25.40	30.33	4.28	10.00	26.99	35.50	4.03	2.91	5.89
MC -7	1.43	25.04	36.00	4.61	9.60	19.16	29.50	18.20	6.99	8.92
MC -8	1.74	25.95	38.45	4.10	14.78	18.93	15.50	4.84	7.50	12.49
MC -9	1.48	26.66	41.83	6.00	14.10	21.33	15.16	2.31	4.08	3.93
MC-10	1.32	27.79	32.35	5.18	15.69	26.49	15.03	8.63	5.45	8.33
MC -11	1.67	25.50	41.66	4.77	14.94	23.16	32.89	12.80	7.63	14.17
MC -12	2.05	27.33	31.85	4.48	10.40	19.50	19.50	9.25	5.88	9.10
MC -13	2.10	28.16	36.55	4.48	17.00	22.16	30.99	5.55	4.05	7.44
MC -14	2.54	26.49	36.01	4.70	9.78	33.00	35.35	4.13	3.44	5.87
MC -15	1.27	24.50	30.34	4.78	16.11	17.99	33.69	8.92	6.10	6.60
MC -16	2.39	21.21	31.20	4.63	15.70	33.50	31.33	17.1	5.34	7.11
MC -17	1.90	22.33	36.10	5.31	18.30	24.99	27.66	12.55	6.42	11.96
MC -18	2.13	20.66	34.24	4.90	19.40	26.99	34.45	7.00	5.48	8.22
MC -19	1.10	22.55	30.92	5.79	18.80	25.83	27.99	8.52	6.28	7.72
MC -20	2.65	27.38	35.54	6.53	15.47	19.66	26.04	24.10	11.60	13.83
SEd	**0.42**	**1.69**	**1.92**	**0.75**	**1.46**	**3.49**	**4.77**	**2.18**	**1.06**	**1.7493**
CD (0.05)	**0.89**	**3.54**	**4.03**	**1.58**	**3.07**	**7.32**	**10.00**	**4.56**	**2.22**	**3.66**

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Table 2. Contd.,

Genotypes	Number of seeds per fruit	Fruit thickness (mm)	Yield per vine (kg)	TSS (°Brix)	Vitamin-C (mg/100g)	Protein (mg/100g)	Momordicine (mg/g)
MC -1	4.1	2.05	0.07	6.30	81.78	2.21	1.60
MC -2	6.3	3.27	0.26	6.45	98.00	3.12	2.34
MC -3	4.2	2.86	0.17	7.08	92.45	1.84	1.64
MC -4	7.5	3.16	0.15	8.93	122.5	2.05	2.02
MC -5	3.6	3.16	0.08	7.33	113.29	3.34	2.21
MC -6	5.7	3.88	0.14	8.00	94.00	3.05	2.62
MC -7	10.3	3.88	0.64	6.39	86.66	2.25	2.11
MC -8	7.5	2.99	0.07	8.59	94.17	2.66	2.31
MC -9	4.4	1.07	0.03	7.47	96.66	2.62	1.99
MC-10	11.0	2.92	0.14	8.34	90.80	3.33	2.88
MC -11	14.4	3.31	0.41	8.46	82.29	3.06	3.19
MC -12	10.6	3.19	0.17	7.68	89.00	2.81	2.57
MC -13	6.0	3.45	0.17	8.20	107.49	3.10	1.96
MC -14	6.55	1.72	0.13	7.88	118.66	2.76	2.48
MC -15	8.6	3.16	0.29	8.20	90.765	3.34	3.09
MC -16	11.7	3.03	0.53	8.26	103.83	3.65	2.97
MC -17	13.3	3.52	0.33	7.83	84.16	2.82	3.12
MC -18	6.2	2.04	0.26	7.95	104.66	3.33	3.61
MC -19	10.9	3.95	0.24	7.98	106.66	3.11	3.24
MC -20	16.8	4.71	0.62	9.29	120.83	3.77	3.12
SEd	**1.99**	**0.70**	**0.07**	**0.60**	**5.50**	**0.49**	**0.50**
CD (0.05)	**4.1789**	**1.47**	**0.16**	**1.26**	**11.51**	**1.04**	**1.05**

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Table 3. Genotypic correlation Co-efficient for different characters in mithipagal

Traits	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17
X1	0.117	0.204	0.034	0.467*	0.448*	0.346	0.211	-0.06	0.046	0.241	-0.169	0.350	0.353	0.839**	0.041	0.206
X2	1.000	0.047	-0.483*	-0.658**	-0.551**	-0.475*	-0.206	0.026	-0.032	-0.087	-0.099	0.021	0.671	-0.380	-0.67	-0.304
X3		1.000	-0.66	-0.120	-0.025	-0.19	-0.154	0.019	0.27	-0.113	-0.773**	-0.324	-0.269	-0.498*	-0.418	-0.107
X4			1.000	0.385	0.402	-0.049	-0.329	-0.084	-0.774**	0.724**	-0.247	0.921**	0.007	-0.877**	-0.981**	-0.604**
X5				1.000	0.234	-0.034	0.083	0.108	-0.245	0.725**	-0.595**	1.067	0.606	0.762**	0.485*	0.144
X6					1.000	0.485*	-0.094	-0.618**	-0.388	0.124	-0.403	0.379	0.078	0.843**	0.859**	0.009
X7						1.000	0.04	-0.276	-0.332	-0.11	0.175	0.199	0.364	0.492*	-0.153	0.250
X8							1.000	0.853**	0.785**	0.933**	0.741**	0.14	0.173	0.581**	0.118	0.971**
X9								1.000	0.992**	0.801**	0.720**	0.37	0.285	0.719**	0.886**	0.744**
X10									1.000	0.764**	0.724**	0.511	-0.046	0.819**	0.960**	0.643**
X11										1.000	0.801**	0.592	0.160	0.920**	0.870**	0.838**
X12											1.000	0.355	0.317	0.857**	0.677**	0.661**
X13												1.000	0.872	0.851**	0.856**	0.110
X14													1.000	0.906**	0.918**	0.100
X15														1.000	0.540*	0.907**
X16															1.000	0.771**

*, ** Significant at 5 and 1 per cent level, respectively

X1 - Vine length (m)
X2 - Days to first male flower appearance
X3 -.Days to first female flower appearance
X4 - Node of first male flower appearance
X5 - Node of first female flower appearance
X6 - Sex ratio(M/F)
X7 - Number of fruits per vine
X8 - Individual fruit weight (g)
X9 - Fruit length (cm)
X10 - Fruit girth (cm)
X11 - Number of seeds per fruit
X12 - Fruit thickness (mm)
X13 - TSS (ºBrix)
X14 - Vitamin-C (mg/100g)
X15 - Protein (mg/100g)
X16 - Momordicine content (mg/g)
X17 - Yield per plant (kg)