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CHARACTER ASSOCIATION STUDIES FOR GROWTH, YIELD AND YIELD ATTRIBUTING TRAITS IN LAND RACES OF KARCHIKAI (*MOMORDICA CYMBALARIA*)

Kavya Mallappa Manni[1], Rekha Chittapur[2*], Prabhuling G.[2], Raghavendra Gunnaiah[3] Namita Raut[4], Dadapeer Peerjade[2], and Veeresh Hiremath[5]

[1]Department of Genetics and Plant Breeding, College of Horticulture, Bagalkot, Karnataka, India
[2]Department of Biotechnology and Crop Improvement, College of Horticulture, Bagalkot, Karnataka, India
[3]Department of Biotechnology & Crop Improvement, College of Horticulture, Bangalore, Karnataka, India
[4]Department of Vegetable Science, College of Horticulture, Bagalkot, Karnataka, India
[5]Department of Postharvest Management, College of Horticulture, Bagalkot, Karnataka, India
*Corresponding author E-mail: rekhah20@gmail.com
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ABSTRACT

An investigation was conducted during *Kharif* 2022 to study the association among traits through correlation coefficient and path coefficient analysis among the 30 landraces of underutilized vegetable crop *Momordica cymbalaria*, known as Karchikai, in the regional language. Nineteen characters comprised of growth, yield, and yield attributing traits were considered in this Study. These genotypes were planted in Randomized Block Design with two replications at the Department of Biotechnology and Crop Improvement, COH, Bagalkot. The results revealed that at genotypic and phenotypic level maximum significant and positive correlation was reported for leaf length (cm), number of fruits per vine and fruit weight (mg). The results of path coefficient analysis indicated that at phenotypic and genotypic levels, the effect was significant, and a positive direct effect on yield per vine (g) was contributed by the character's fruit weight (mg), vine length at 45 DAS, days to first male flower, leaf length (cm), shelf life, number of days of last harvest, days to 50% flowering, fruit length (cm), tuber weight (g), number of nodes per vine, days to first female flower, node number of the first female flower, days to first male flower, sex ratio. Hence, these characters may be considered for direct and indirect selections for developing superior high-yielding varieties of karchikai.

***Keywords*:** Karchikai, Momordica cymbalaria, Correlation, fruit yield, Path analysis, phenotypic and genotypic

Introduction

Karchikai *(Momordica cymbalaria*, 2n=2x=18), also known as Kakrol, Athalakkai, and Kasarakayee, is a perennial climbing vine of the family Cucurbitaceae (Nikam*et al.*,2009) originated in tropical regions of India and South East Asia. In India, Karnataka, Madhya Pradesh, Maharashtra, Andhra Pradesh, and Tamil Nadu are native to *Momordica cymbalaria*. Fruits have high calcium, potassium, vitamin C, and crude fiber (Rao *et al.*, 1999). Fruit extracts have been found to exhibit antidiabetic, hypolipidemic, anti-diarrheal, antiulcer, cardioprotective, anti-microbial, nephroprotective, and anti-cancerous effects (Bharathi *et al.*, 2010). Correlation coefficients of various attributes are very useful in studying the association among the fruit yield-contributing traits that will contribute to fruit yield improvement and assessing the degree to which these traits are associated with

economic productivity. Since dependent variables are influenced by many independent variables, in order to consider the complex relationship among various variables, path coefficient analysis reveals the strength of association and dissecting out the direct and indirect effects of yield contributing traits towards the fruit yield per plant, by applying effective selection strategies for with a target to enhance the fruit yield.

Material and Methods

The investigation was conducted at the Department of Biotechnology and Crop Improvement, COH, Bagalkot during *Kharif* 2022. The experimental material comprises 30 karchikai landraces explored from different Karnataka districts. The experiment was planned with a Randomized Block Design of two replications. The row-to-row spacing of 1.5 m. and plant-to-plant spacing of 1 m were maintained. Observations were recorded on three randomly selected plants for nineteen traits, viz., vine length at 45 DAS, days to 50 percent flowering, days to first male flower, days to first female flower, node number of the first female flower, sex ratio, tuber weight, leaf length, number of days of first harvest, number of days of last harvest, number of branches per vine, number of nodes per vine, internodal length, number of fruits per vine, fruit weight, yield per vine, fruit length, fruit diameter, and shelf life. The mean values were used for statistical analysis. Phenotypic and genotypic correlations worked out by using formula suggested by Al-Jibouri *et al*. 1958. As Dewey and Lu (1959) suggested, path coefficient analysis was carried out by partitioning the simple correlation coefficients into direct and indirect effects.

Results

The association among the yield traits was studied based on correlation and path coefficient analysis are useful to understand the direction and strength of associations among the yield attributing traits which will help in the selection of desirable types based on the traits that are directly or indirectly influencing the yielding ability of an individual.

Correlation coefficient analysis

Crop improvement is accomplished by selection based on diverse set of morphological traits. By understanding the associations between the traits, breeders can improve the effectiveness of selection. Correlations between the characters in plants will help identify the traits from which karchikai's economic traits can be improved genetically. It demonstrates the degree to which two traits are related and indicates whether simultaneous improvement in the particular attributes is feasible.

The correlation coefficients for 19 characters at the phenotypic and genotypic levels were computed to gain an overview of the interrelationships between yield-contributing traits, and they are represented in Table 1.

Phenotypic correlation

At the phenotypic level, there were significant positive correlations between various characters. For instance, yield per vine exhibited a substantial positive correlation with leaf length (rp = 0.3128) and demonstrated a highly significant positive correlation with both the number of fruits per vine (rp = 0.8910) and fruit weight (rp = 0.5221). Additionally, vine length at 45 days after sowing (DAS) displayed a significant positive correlation with the number of fruits per plant (rp = 0.2905) and a highly significant positive correlation with the number of nodes per vine (rp = 0.9899). The number of days to the first male flower had a significant positive correlation with the number of days to the last harvest (rp = 0.2773) and the number of days to the first harvest (rp = 0.2847), as well as with fruit length (rp = 0.3121). The number of nodes on the first female flower exhibited a significant positive correlation with the sex ratio (rp = 0.3031) and internode length (rp = 0.2993). Furthermore, the sex ratio significantly correlated with fruit length (rp = 0.3476). Tuber weight had a highly significant positive correlation with the number of branches per vine (rp = 0.3523). Leaf length displayed significant positive correlations with the number of days for the last harvest (rp = 0.2564), the number of fruits per vine (rp = 0.2551), and yield per vine (rp = 0.3128). The number of branches per vine exhibited a significant positive correlation with shelf life (rp = 0.2732) and a highly significant positive correlation with the number of fruits per vine (rp = 0.3514). The number of nodes per vine had a significant positive correlation with the number of fruits per vine (rp = 0.2613). The number of fruits per vine had a highly significant positive correlation with yield per vine (rp = 0.891). At the same time, fruit weight also had a highly significant positive correlation with yield per vine (rp = 0.5221).

At the phenotypic level, the yield per vine exhibited a notable negative association with the number of days to first harvest (rp = -0.3016) and fruit length (rp = -0.3282). Similarly, the number of days to 50% flowering displayed a significant negative

association with the number of branches per vine (rp = -0.2813). The days to the first male flower had a significant negative association with the number of fruits per vine (rp = -0.3046) and exhibited a highly significant negative correlation with tuber weight (rp = -0.3503). Furthermore, the number of days to first harvest showed significant negative correlations with the number of fruits per vine (rp = -0.2977), yield per vine (rp = -0.3016), and displayed a highly significant negative correlation with internodal length (rp = -0.4018). Lastly, the number of fruits per vine was significantly negatively correlated with fruit length (rp =-0.3274), and fruit length exhibited a significant negative correlation with yield per vine (rp = -0.3282).

Genotypic correlation

At the genotypic level, the yield per vine exhibited a substantial positive relationship with leaf length (rg = 0.4) and a highly significant positive association with both the number of fruits per vine (rg = 0.9237) and fruit weight (rg = 0.5177). The vine's length at 45 days after sowing (DAS) displayed a significant positive correlation with shelf life (rg = 0.3792) and had a highly significant positive correlation with the number of nodes per vine (rg = 1.0032). The number of days to the first appearance of male flowers had a significant positive correlation with the number of days to last harvest (rg = 0.3741). Days to the first female flower showed a highly significant positive correlation with fruit weight (rg = 0.497). The node number of the first female flower exhibited a significant positive correlation with fruit diameter (rg = 0.3972). The sex ratio positively correlated with fruit length (rg = 0.3976). Tuber weight significantly correlated with the number of branches per vine (rg =0.3976). Leaf length significantly correlated with the days until the last harvest (rg = 0.3976) and the yield per vine (rg = 0.4). The number of branches per vine had a highly significant positive correlation with the number of fruits per vine (rg = 0.4715). The number of nodes per vine significantly positively correlated with shelf life (rg = 0.3669). The number of fruits per vine had a highly significant positive correlation with the yield per vine (rg = 0.9237). Fruit weight showed a significant positive correlation with fruit diameter (rg = 0.444) and a highly significant positive correlation with yield per vine (rg = 0.5177).

At the genotypic level, yield per vine had a significant negative correlation with days to fruit harvest (rg =-0.4095) and fruit length (rg =-0.3872). Days to first male flower had a significant negative correlation with tuber weight (rg =-0.413) and the number of fruits per vine (rg =-0.4446). Days to the first female flower showed a significant negative correlation with several days of the last harvest (rg =-0.4049). Several days of first harvest had a significant negative correlation with internodal length (rg =-0.4593), number of fruits per vine (rg =-0.3868), and yield per vine (rg =-0.4095). The number of fruits per vine had a significant negative correlation with fruit length (rg =- 0.3951). Fruit length significantly negatively correlated with yield per vine (rg =-0.3872).

Path coefficient analysis

Path coefficient analysis is an essential tool for determining the direct and indirect effects of independent variables on a dependent variable from the correlation coefficients. Tables 2 depict the examination of the genotypic and phenotypic paths that divide the total correlation coefficient of various characteristics into their direct and indirect effects on growth and yield-related attributes.

Direct effect

Phenotypic path coefficient revealed highest positive direct effect of number of fruits per vine (0.8623) followed by fruit weight (0.4430), vine length at 45 DAS (0.1918), days to first male flower (0.02802), leaf length (0.0141), shelf life (0.0126), number of days of last harvest (0.0100), days to 50% flowering (0.0084), fruit length (0.0075), tuber weight (0.0009). However, the number of nodes per vine (-0.1895), number of branches per vine (-0.0290), number of days of first harvest (-0.0275), internodal length (-0.0169), fruit diameter (-0.0081), node number of first female flower (-0.0071), days to first female flower (-0.0040), sex ratio (-0.0031) exerted direct negative effect on yield.

At genotypic level number of fruits per vine (0.9352) had highest positive direct effect on yield followed by number of nodes per vine (0.3880), days to first female flower (0.3220), number of days of last harvest (0.2825), node number of first female flower (0.2048), days to first male flower (0.1524), fruit weight (0.1330), sex ratio (0.0334). However, number of branches per vine (-0.3056), fruit length (-0.2587), vine length at 45 DAS (-0.2223), fruit diameter (-0.1818), days to 50% flowering (-0.1445), leaf length (-0.0948), shelf life (-0.0928), internodal length (-0.0606), number of days of first harvest (-0.0587),

tuber weight (-0.0420) exerted direct negative effect on yield.

The components of the residual effect of path analysis in growth, yield, and yield-attributing traits are 0.0051 at both phenotypic and genotypic levels. A lower residual effect indicated the least influence of the environment, and other traits chosen for analysis were adequate. Traits selected for evaluation will be useful for empowering the yield parameters.

Indirect effect

At genotypic level

At the genotypic level, the number of nodes per vine (0.3892) had the highest positive indirect effect on vine length at 45 DAS, followed by several fruits per vine (0.3073), days to the first female flower (0.0861). Several branches per vine (0.1050) had the highest positive indirect effect on days to 50% flowering, followed by fruit diameter (0.0440), and fruit length (0.0382). Several days of last harvest (0.1056) had the highest positive indirect effect on days to the first male flowers, followed by vine length at 45 DAS (-0.0531), the node number of the first female flower (0.0521). Several fruits per vine (0.1324) had the highest positive indirect effect on the days to the first female flower, followed by several nodes per vine (0.1062), and fruit weight (0.0661). Several fruits per vine (0.1393) had the highest positive indirect effect on the node number of the first female flowers, followed by days to the first female flower (0.0539), and days to 50% flowering (0.0423). Node number of the first female flower (0.0721) had the highest positive indirect effect on the sex ratio, followed by days to the first female flower (0.0696), and days to the first male flower (0.0227). Several fruits per vine (0.2393) had the highest positive indirect effect on tuber weight, followed by days to the first female flower (0.0611) and fruit diameter (0.0515). The number of fruits per vine (0.3040) had the highest positive indirect effect on leaf length, followed by several days of the last harvest (0.1048), the node number of the first female flower (0.0377). The number of days of the last harvest (0.0520) had the highest positive indirect effect on the number of days of the first harvest, followed by days to the first male flower (0.0421) and internodal length (0.0278). The number of fruits per vine (0.4409) had the highest positive indirect effect on the number of branches per vine, followed by the number of nodes per vine (0.0916) and days to the first female flower (0.0704). A number of fruits per vine (0.2603) had the highest positive indirect effect on the number of nodes per vine, followed by days to the first female flower (0.0881) and leaf length (0.0152).The number of fruits per vine (0.2297) had the highest positive indirect effect on internodal length, followed by days to the first female flower (0.0803) and node number of the first female flower (0.0701). The number of nodes per vine (0.1080) had the highest positive indirect effect on several fruits per vine, followed by fruit length (0.1022) and days to the first female flower (0.0455).Days to the first female flower (0.1600) had the highest positive indirect effect on fruit weight, followed by the number of fruits per vine (0.1456) and the number of branches per vine (0.0544). Days to the first female flower (0.1043) had the highest positive indirect effect on fruit length, followed by node number of the first female flower (0.0553) and days to the first male flower (0.0539).Number of branches per vine (0.0897) had highest positive indirect effect on fruit diameter followed by node number of first female flower (0.0814), node number of first female flower (0.0814). A number of nodes per vine (0.1423) had the highest positive indirect effect on shelf life, followed by the number of days of last harvest (0.0446) and days to first male flower (0.0441).

At phenotypic level

At phenotypic level, number of fruits per vine (0.2505) had highest positive indirect effect on vine length at 45 DAS followed by shelf life (0.0028), number of days of first harvest (0.0028). Number of branches per vine (0.0081) had highest positive indirect effect on days to 50% flowering followed by vine length at 45 DAS (0.0043), internodal length (0.0019). Fruit weight (0.0587) had highest positive indirect effect on days to first male flower followed by number of nodes per vine (0.0257), number of days of last harvest (0.0028). Several fruits per vine (0.0884) had the highest positive indirect effect on days to the first female flower, followed by fruit weight (0.0773) and vine length at 45 DAS (0.0308). The number of fruits per vine (0.1105) had a positive indirect effect on the node number of the first female flower, followed by fruit weight (0.0293) the number of nodes per vine (0.0291). Fruit weight (0.0117) had a positive indirect effect on the sex ratio, followed by days to first male flower (0.0037) and number of nodes per vine (0.0032). The number of fruits per vine (0.1719) had a positive indirect effect on tuber weight, followed by vine length at 45 DAS (0.0216) and the number of days of first harvest (0.0045). The number of fruits per vine (0.2196) had the highest positive indirect effect on leaf length, followed by fruit weight (0.0769) and number

of nodes per vine (0.0299). The number of nodes per vine (0.0381) had the highest positive indirect effect on the number of days of the last harvest, followed by days to the first male flower (0.0077) and internodal length (0.0039). Number of nodes per vine (0.0198) had highest positive indirect effect on number of days of first harvest followed by days to first male flower (0.0079), internodal length (0.0068). Number of fruits per vine (0.3030) had highest positive indirect effect on number of branches per vine followed by plant height at 45 day (0.0410), shelf life (0.0034). Number of fruits per vine (0.2253) had highest positive indirect effect on number of nodes per vine followed by vine length at 45 DAS (0.1899), number of days of first harvest (0.0028). The number of fruits per vine (0.1680) had the highest positive direct effect on internodal length, followed by fruit weight (0.0818) and vine length at 45 DAS (0.0250). Vine length at 45 DAS (0.0557) had the highest positive indirect effect on the number of fruits per vine, followed by fruit weight (0.0391) and number of days of first harvest (0.0082). A number of fruits per vine (0.0762) had the highest positive indirect effect on fruit weight, followed by a number of nodes per vine (0.0037), and days to the first male flower (0.0037). Days to first female flower (0.0087) had highest positive indirect effect on fruit length followed by leaf length (0.0028), number of branches per vine (0.0015). Fruit weight (0.1030) had the highest positive indirect effect on fruit diameter, followed by vine length at 45 DAS (0.0164) and number of branches per vine (0.0068). Vine length at 45 DAS (0.0427) had highest positive indirect effect on shelf life followed by days to first male flower (0.0050), internodal length (0.0019).

Discussion

Developing multiple traits simultaneously in any crop improvement program becomes crucial, especially when dealing with a complex variable like yield that is influenced by several other traits. This is because of how the genes controlling different traits function and their genetic linkages. Therefore, understanding the relationships between various economic characteristics is essential for selection programs. Positive correlation allows for the simultaneous improvement of two or more characteristics, but negative correlation suggests that desirable characteristics must be compromised (Kumaran *et al*., 2000).

The number of fruits per vine, fruit weight, and leaf length all showed a significant positive association with yield per vine and negative relationship between fruit length and number of days of first harvest. This suggests that an increase in leaf length, fruit weight, and number of fruits per vine will all improve yield per vine. The comparable results were supported the Study conducted by Arunkumar *et al*. (2011). We can infer from the positive correlation that fruit parameters play the most significant role in determining high yield in Kartika.

Phenotypic correlation results reported a strong positive correlation between vine length at 45 DAS and the number of fruits and nodes per plant. There was a negative correlation between the number of branches per vine and the days to 50% flowering (Golabadi *et al.*, 2013). Days to first male flowering, number of days of first harvest, and fruit length all showed a substantial positive association (Hossain *et al.*, 2010). They were negatively correlated with tuber weight and the number of fruits produced by each plant. The sex ratio and internode length positively connected with the node number of the first female flower. Fruit length and the sex ratio are positively associated (Saikia *et al.*, 1995). The number of branches per vine exhibited a statistically significant positive connection with tuber weight. The number of fruits on a plant, the number of days of the last harvest, and the yield per vine significantly correlated positively with leaf length. Days before the first harvest were significantly inversely correlated with internodal length, yield per vine, and number of fruits per vine (Golabadi *et al.*, 2013).

A strong positive correlation existed between the number of branches and fruits per plant. A strong positive correlation existed between the number of nodes per vine and shelf life. Fruit length and number of fruits per vine showed a strong negative correlation, but yield per vine showed a substantial positive correlation. Fruit diameter and yield per vine showed a strong positive association with fruit weight. There was a notable inverse relationship between fruit length and yield per vine. Similar findings with bitter gourd were previously reported by Mangal *et al.* (1979), Srivastava and Srivastava (1976), and Singh *et al.* (2015).

The number of fruits per vine, fruit weight, and leaf length all showed a significant positive correlation with yield per vine and a negative correlation between fruit length and the number of days of first harvest. Vine length at 45 DAS and the quantity of fruit and nodes per plant showed a strong positive correlation. There was a substantial negative correlation between the number of branches per vine and the days to 50% flowering. Days to first male flower, number of days of

first harvest, and fruit length all showed a strong positive association and showed a negative connection with tuber weight and fruit number per plant. The sex ratio and internode length showed a substantial positive connection with the node number of the first female flower. Fruit length and the sex ratio are positively associated (Saikia *et al*., 1995). The number of branches per vine exhibited a statistically significant positive connection with tuber weight. The number of fruits on a plant, number of days of last harvest, and the yield per vine were significantly correlated positively with leaf length. Days before the first harvest were significantly inversely correlated with internodal length, yield per vine, and number of fruits per vine. Similar results for cucumber were also reported by Saikia *et al*. (1995).

There was a strong positive correlation between the number of branches and fruits per plant. There was a strong positive correlation between the number of nodes per vine and shelf life. Fruit length and number of fruits per vine showed a strong negative correlation, but yield per vine showed a substantial positive correlation. Fruit diameter and production per plant showed a strong positive association with fruit weight. There was a notable inverse relationship between fruit length and yield per vine. Ramachandran and Gopalakrishnan (1979) noted similar things about fruit length, weight, and number of fruits per vine.

Fruit weight, vine length at 45 DAS, days to first male flower, leaf length, shelf life, number of days of last harvest, days to 50% flowering, fruit length, and tuber weight were the following factors that positively direct effect on yield at the phenotypic level. However, the number of fruit diameters, internodal length, sex ratio, node number of the first female flower, days to the first female flower, number of branches per vine, number of days of the first harvest, and internodal length all negatively impacted yield. This aligns with findings reported by Parhi *et al*. (1995).

At the phenotypic level, number of fruits per vine recorded the highest positive direct effect on yield, followed by fruit weight, vine length at 45 DAS, days to first male flower, leaf length, shelf life, number of days of last harvest, days to 50% flowering, fruit length, tuber weight. However, the number of nodes per vine, number of branches per vine, number of days of the first harvest, internodal length, fruit diameter, the node number of the first female flower, days to the first female flower, and sex ratio directly affected yield. Traits like vine length at 45 DAS, days to first female flower, node number of first female flower, tuber weight, leaf length, days to last harvest, number of branches per vine, number of nodes per vine, internodal length, number of fruits per vine, fruit weight, fruit diameter had positive indirect effect whereas other traits exhibited negative indirect effect on yield. The similar reports were recorded by Mangal *et al.* (1979).

The number of fruits per vine had the most significant positive direct effect on yield at the genotypic level, followed by the number of nodes per vine, days to first female flower, number of days of last harvest, the weight of the fruit, and the sex ratio. However, there was a direct negative impact on yield from the number of branches per vine, fruit length, vine length at 45 DAS, fruit diameter, days to 50% flowering, leaf length, shelf life, internodal length, number of days of first harvest, and tuber weight. Vine length at 45 DAS, node number of the first female flower, sex ratio, tuber weight, leaf length, number of branches per vine, number of nodes per vine, internodal length, number of fruits per vine, fruit weight, fruit diameter had positive indirect effect on yield while remaining traits showed a negative indirect effect on yield similar to the reports recorded by (Saikia *et al*., 1995). The results from path analysis among karchikai land races revealed that greater emphasis was given to the traits that directly affected yield.

Conclusion

For character association studies, genotypic and phenotypic correlations were considered. In most cases, genotypic correlation coefficients were higher than phenotypic correlations, indicating the highly heritable nature of the character. The traits of leaf length, number of fruits per vine, and fruit weight showed significant association with the yield per vine and can be simultaneously selected for improving the fruit yield per vine. The path coefficient analysis at both genotypic and phenotypic levels revealed that fruit weight and vine length at 45 DAS were the most influencing factors. Thus, these characters deserve greater weight during the selection for yield. The residual effect at both genotypic and phenotypic levels was meager, indicating the influence of traits other than those considered for the study.

Table 1 : Phenotypic (P) and Genotypic (G) correlation coefficients of growth, yield and yield attributes in 30 landraces of Karchikai

		VL	DFF	DFMF	DFFF	NFF	SR	TW	LL	DLH	DFH	NBV	NNV	IL	NFV	FW	FL	FD	SL	YV
VL	P	1 **	0.023	-0.145	0.161	-0.125	-0.008	0.113	-0.162	-0.217	-0.102	0.214	0.9899 **	0.130	0.2905 *	-0.003	-0.006	0.087	0.223	0.242
	G	1 **	0.061	-0.239	0.267	-0.147	-0.033	0.126	-0.157	-0.240	-0.085	0.266	1.0032 **	0.137	0.329	-0.008	0.002	0.202	0.3792 *	0.267
DFF	P		1 **	-0.215	-0.039	-0.206	-0.048	-0.080	-0.124	0.048	0.189	-0.2813 *	0.031	-0.113	-0.088	-0.070	-0.147	-0.182	-0.132	-0.102
	G		1 **	-0.236	-0.123	-0.293	-0.049	-0.067	-0.158	0.129	0.230	-0.344	0.066	-0.109	-0.132	-0.167	-0.148	-0.242	-0.123	-0.169
DFMF	P			1 **	-0.171	0.224	0.134	-0.3503 **	0.098	0.2773 *	0.2847 *	-0.028	-0.136	0.035	-0.3046 *	0.133	0.3121 *	0.053	0.180	-0.181
	G			1 **	-0.207	0.254	0.149	-0.4130 *	0.095	0.3741 *	0.277	-0.023	-0.251	0.050	-0.4446 *	0.208	0.354	0.122	0.290	-0.294
DFFF	P				1 **	0.203	0.219	0.131	0.026	-0.207	-0.086	0.165	0.158	0.126	0.103	0.175	0.242	-0.056	0.057	0.152
	G				1 **	0.168	0.216	0.190	0.047	-0.4049 *	-0.072	0.219	0.274	0.250	0.142	0.4970 **	0.324	0.053	-0.029	0.300
NFF	P					1 **	0.3031 *	-0.086	0.120	-0.162	-0.060	0.187	-0.154	0.2993 *	0.128	0.066	0.252	0.209	0.115	0.134
	G					1 **	0.352	-0.094	0.184	-0.242	-0.141	0.215	-0.173	0.343	0.149	0.028	0.270	0.3972 *	0.208	0.139
SR	P						1 **	0.162	0.010	-0.048	-0.042	-0.051	-0.017	0.117	-0.084	0.027	0.3476 **	0.186	0.123	-0.058
	G						1 **	0.186	0.012	-0.090	-0.055	-0.053	-0.032	0.149	-0.052	0.063	0.3976 *	0.306	0.080	-0.031
TW	P							1 **	0.021	0.063	-0.166	0.3523 **	0.105	0.035	0.199	-0.183	0.048	-0.219	0.051	0.080
	G							1 **	0.011	0.071	-0.192	0.3798 *	0.122	0.033	0.256	-0.257	0.052	-0.283	0.102	0.118
LL	P								1 **	0.2564 *	0.047	-0.031	-0.158	-0.001	0.2551 *	0.174	0.195	-0.044	-0.123	0.3128 *
	G								1 **	0.3710 *	0.048	-0.042	-0.160	0.256	0.325	0.274	0.202	-0.038	-0.237	0.4000 *
DLH	P									1 **	0.075	-0.042	-0.201	-0.229	-0.150	-0.061	0.055	-0.012	0.056	-0.131
	G									1 **	0.184	-0.026	-0.238	-0.303	-0.098	-0.005	0.087	-0.013	0.158	-0.051
DFH	P										1 **	0.040	-0.105	-0.4018 **	-0.2977 *	-0.088	0.030	-0.136	0.203	-0.3016 *
	G										1 **	0.004	-0.066	-0.4593 *	-0.3868 *	-0.169	-0.027	-0.090	0.218	-0.4095 *
NBV	P											1 **	0.201	0.085	0.3514 **	-0.051	-0.054	-0.226	0.2732 *	0.251
	G											1 **	0.236	0.112	0.4715 **	-0.178	-0.043	-0.293	0.339	0.310
NNV	P												1 **	0.109	0.2613 *	-0.020	-0.001	0.070	0.196	0.207
	G												1 **	0.120	0.278	-0.007	0.014	0.190	0.3669 *	0.223
IL	P													1 **	0.195	0.185	0.117	-0.085	-0.109	0.241
	G													1 **	0.246	0.291	0.124	-0.133	-0.116	0.311
NFV	P														1 **	0.088	-0.3274 *	-0.054	-0.102	0.891 **
	G														1 **	0.156	-0.3951 *	0.005	-0.123	0.9237 **
FW	P															1 **	-0.134	0.236	-0.151	0.5221 **
	G															1 **	-0.158	0.4440 *	-0.285	0.5177 **
FL	P																1 **	0.008	0.072	-0.3282 *
	G																1 **	-0.055	0.126	-0.3872 *
FD	P																	1 **	0.050	0.063
	G																	1 **	0.291	0.175
SL	P																		1 **	-0.147
	G																		1 **	-0.222
YV	P																			1 **
	G																			1 **

Significance Levels * Significant ** highly significant

VL - Vine length at 45 DAS (cm)
DFH - Number of days of first harvest
YV - Yield per vine (g)
IL - Internodal length (cm)
FW - Fruit weight (mg)
DLH - Number of days of last harvest
SL - Shelf life (days)
DFFF - Days to first female flower
SR - Sex ratio
LL - Leaf length (cm)
FD- Fruit diameter (cm)
DFMF- Days to first male flower
NNV - Number of nodes per vine
NFV - Number of fruits per vine
FL - Fruit length (cm)
DFF - Days to 50% flowering
NBV - Number of branches per vine
NFF - Node number of first female flower
TW - Tuber weight (g)

Table 2 : Phenotypic (P) and Genotypic (G) path coefficient analysis on fruit yield per vine in 30 landraces of Karchikai

		VL	DFF	DFMF	DFFF	NFF	SR	TW	LL	DLH	DFH	NBV	NNV	IL	NFV	FW	FL	FD	SL	(R^2)
	P	**0.192**	0.000	-0.004	-0.001	0.001	0.000	0.000	-0.002	-0.002	0.003	-0.006	-0.188	-0.002	0.251	-0.001	0.000	-0.001	0.003	0.242
VL	G	**-0.222**	-0.009	-0.036	0.086	-0.030	-0.001	-0.005	0.015	-0.068	0.005	-0.081	0.389	-0.008	0.307	-0.001	-0.001	-0.037	-0.035	0.267
	P	0.004	**0.009**	-0.006	0.000	0.002	0.000	0.000	-0.002	0.001	-0.005	0.008	-0.006	0.002	-0.076	-0.031	-0.001	0.001	-0.002	-0.102
DFF	G	-0.014	**-0.145**	-0.036	-0.040	-0.060	-0.002	0.003	0.015	0.036	-0.014	0.105	0.025	0.007	-0.123	-0.022	0.038	0.044	0.011	-0.169
	P	-0.028	-0.002	**0.028**	0.001	-0.002	0.000	0.000	0.001	0.003	-0.008	0.001	0.026	-0.001	-0.263	0.059	0.002	0.000	0.002	-0.181
DFMF	G	0.053	0.034	**0.152**	-0.067	0.052	0.005	0.017	-0.009	0.106	-0.016	0.007	-0.097	-0.003	-0.416	0.028	-0.092	-0.022	-0.027	-0.294
	P	0.031	0.000	-0.005	**-0.004**	-0.002	-0.001	0.000	0.000	-0.002	0.002	-0.005	-0.030	-0.002	0.089	0.077	0.002	0.000	0.001	0.152
DFFF	G	-0.059	0.018	-0.032	**0.322**	0.034	0.007	-0.008	-0.004	-0.114	0.004	-0.067	0.106	-0.015	0.132	0.066	-0.084	-0.010	0.003	0.300
	P	-0.024	-0.002	0.006	-0.001	**-0.007**	-0.001	0.000	0.002	-0.002	0.002	-0.006	0.029	-0.005	0.111	0.029	0.002	-0.002	0.001	0.134
NFF	G	0.033	0.042	0.039	0.054	**0.205**	0.012	0.004	-0.018	-0.068	0.008	-0.066	-0.067	-0.021	0.139	0.004	-0.070	-0.072	-0.019	0.139
	P	-0.002	0.000	0.004	-0.001	-0.002	**-0.003**	0.000	0.000	-0.001	0.001	0.002	0.003	-0.002	-0.072	0.012	0.003	-0.001	0.002	-0.058
SR	G	0.007	0.007	0.023	0.070	0.072	**0.033**	-0.008	-0.001	-0.025	0.003	0.016	-0.013	-0.009	-0.049	0.008	-0.103	-0.056	-0.007	-0.031
	P	0.022	-0.001	-0.010	-0.001	0.001	-0.001	**0.001**	0.000	0.001	0.005	-0.010	-0.020	-0.001	0.172	-0.081	0.000	0.002	0.001	0.080
TW	G	-0.028	0.010	-0.063	0.061	-0.019	0.006	**-0.042**	-0.001	0.020	0.011	-0.116	0.047	-0.002	0.239	-0.034	-0.013	0.052	-0.010	0.118
	P	-0.031	-0.001	0.003	0.000	-0.001	0.000	0.000	**0.014**	0.003	-0.001	0.001	0.030	0.001	0.220	0.077	0.002	0.000	-0.002	0.313
LL	G	0.035	0.023	0.014	0.015	0.038	0.000	-0.001	**-0.095**	0.105	-0.003	0.013	-0.062	0.000	0.304	0.037	-0.052	0.007	0.022	0.400
	P	-0.042	0.000	0.008	0.001	0.001	0.000	0.000	0.004	**0.010**	-0.002	0.001	0.038	0.004	-0.129	-0.027	0.000	0.000	0.001	-0.131
DLH	G	0.054	-0.019	0.057	-0.130	-0.050	-0.003	-0.003	-0.035	**0.283**	-0.011	0.008	-0.092	0.018	-0.092	-0.001	-0.023	0.002	-0.015	-0.051
	P	-0.020	0.002	0.008	0.000	0.000	0.000	0.000	0.001	0.001	**-0.028**	-0.001	0.020	0.007	-0.257	-0.039	0.000	0.001	0.003	-0.302
DFH	G	0.019	-0.033	0.042	-0.023	-0.029	-0.002	0.008	-0.005	0.052	**-0.059**	-0.001	-0.026	0.028	-0.362	-0.023	0.007	0.016	-0.020	-0.410
	P	0.041	-0.002	-0.001	-0.001	-0.001	0.000	0.000	-0.001	0.000	-0.001	**-0.029**	-0.038	-0.001	0.303	-0.022	0.000	0.002	0.003	0.251
NBV	G	-0.059	0.050	-0.004	0.071	0.044	-0.002	-0.016	0.004	-0.007	0.000	**-0.306**	0.092	-0.007	0.441	-0.024	0.011	0.053	-0.032	0.310
	P	0.190	0.000	-0.004	-0.001	0.001	0.000	0.000	-0.002	-0.002	0.003	-0.006	**-0.190**	-0.002	0.225	-0.009	0.000	-0.001	0.003	0.207
NNV	G	-0.223	-0.010	-0.038	0.088	-0.036	-0.001	-0.005	0.015	-0.067	0.004	-0.072	**0.388**	-0.007	0.260	-0.001	-0.004	-0.035	-0.034	0.223
	P	0.025	-0.001	0.000	-0.001	-0.002	0.000	0.000	0.000	-0.002	0.011	-0.002	-0.021	**-0.017**	0.168	0.082	0.001	0.001	-0.001	0.241
IL	G	-0.031	0.016	0.008	0.080	0.070	0.005	-0.001	0.000	-0.086	0.027	-0.034	0.047	**-0.061**	0.230	0.039	-0.032	0.024	0.011	0.311
	P	0.056	-0.001	-0.009	0.000	-0.001	0.000	0.000	0.004	-0.002	0.008	-0.010	-0.050	-0.003	**0.862**	0.039	-0.003	0.000	-0.001	0.891
NFV	G	-0.073	0.019	-0.068	0.046	0.031	-0.002	-0.011	-0.031	-0.028	0.023	-0.144	0.108	-0.015	**0.935**	0.021	0.102	-0.001	0.011	0.924
	P	-0.001	-0.001	0.004	-0.001	-0.001	0.000	0.000	0.003	-0.001	0.002	0.002	0.004	-0.003	0.076	**0.443**	-0.001	-0.002	-0.002	0.522
FW	G	0.002	0.024	0.032	0.160	0.006	0.002	0.011	-0.026	-0.002	0.010	0.054	-0.003	-0.018	0.146	**0.133**	0.041	-0.081	0.026	0.518
	P	-0.001	-0.001	0.009	-0.001	-0.002	-0.001	0.000	0.003	0.001	-0.001	0.002	0.000	-0.002	-0.282	-0.060	**0.008**	0.000	0.001	-0.328
FL	G	0.000	0.021	0.054	0.104	0.055	0.013	-0.002	-0.019	0.025	0.002	0.013	0.006	-0.008	-0.370	-0.021	**-0.259**	0.010	-0.012	-0.387
	P	0.016	-0.002	0.001	0.000	-0.002	-0.001	0.000	0.000	0.000	0.004	0.007	-0.013	0.002	-0.046	0.103	0.000	**-0.008**	0.001	0.063
FD	G	-0.045	0.035	0.019	0.017	0.082	0.010	0.012	0.004	-0.004	0.005	0.090	0.074	0.008	0.005	0.059	0.014	**-0.182**	-0.027	0.175
	P	0.043	-0.001	0.005	0.000	-0.001	0.000	0.000	-0.002	0.001	-0.006	-0.008	-0.037	0.002	-0.088	-0.067	0.001	0.000	**0.013**	-0.146
SL	G	-0.084	0.018	0.044	-0.009	0.043	0.003	-0.004	0.023	0.045	-0.013	-0.104	0.142	0.007	-0.115	-0.038	-0.033	-0.053	**-0.093**	-0.222

Residual effect =0.0051 Diagonal values indicate direct effect

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