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Assessment of Path Co-efficient Analysis for Yield and Yield Attributing Traits in Sponge Gourd [*Luffa cylindrica* (L.) Roem.]

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This investigation was conducted to determine the path coefficient analysis using 40 genotypes of sponge gourd at the experimental plot of Department of Vegetable Science, College of Horticulture, UHS, Bagalkot (Karnataka) in RBD design along with two replications during the year 2020-2021. Path co-efficient analysis considered as one of the best statistical methods which can help breeders to characterize the genotypes during the parent selection program and select the desirable genotypes for higher yield production. Path coefficients analysis showed thatthe traits like number of fruits per vine, average fruit weight, fruit length, number of branches per vine and vine length had positive direct effect on fruit yield per vine. Thus the higher magnitude of positive direct effect of these traits explains the higher value of association between these traits on yield per vine. Therefore, direct selection for these traits would reward for yield improvement in sponge gourd.

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1. INTRODUCTION

"The sponge gourd (*Luffa cylindrica* Roem Syn. *Luffa aegyptiaca*) is one of the significant members of the cucurbit family of vegetable crops. The Middle East, India, China, Japan, and Malaysia have been cultivating sponge gourds for centuries" [1]. "Sponge gourd is native to Tropical Asia, probably India and South East Asia" [2]. The soft or immature sponge gourd fruits are consumed as cooked vegetables or used in curries and chutneys. When eaten, the soft fruits increase the appetite and are easily digested [3].

"It is nutritive vegetable rich in vitamin A, vitamin C and minerals (Mg, Ca, Na, K, Fe, Cu, Zn and Mn). It contains moisture of 93.2 g, protein 1.2 g, fat 0.2 g, carbohydrates 2.9 g and vitamins like, thiamine (0.02 mg), riboflavin (0.06 mg) and fibres (0.20 g) per 100 g of edible portion. The fruits of sponge gourd also have higher levels of protein and carotene than the ridge gourd" [4].

Fruits of this crop are best for the treatment of fever, jaundice, diabeties and hypertension. The presence of ribosome-inactivating protein in the seeds of sponge gourd said to be had anti-HIV activity. The oil extracted from the seeds of this crop is used for industrial purpose, treatment of leprosy and against many skin diseases [5]. "The mature dry fruits of this crop consists of dense network of cellulose fibers called as sponge or luffa which is used as filter and cleaning the motor car, glass wares, kitchen utensils and preparation of bathing accessories which increases the blood circulation and it is also credited as relief for rheumatic and arthritic suffers" [1].

"Sponge gourd is an annual climber with branched tendrils. It is highly cross pollinated crop due to the presence of monoecious sex form, however, other sex forms like hermaphrodite, staminate and pistillate flowers were also found in nature. Breeding for high yield is the major objective in any crop improvement programme. The studies on components of variability and heritability do not throw light on the extent and nature of relationship existing between yield and various contributory characters. Hence, the correlation and path analysis are known to help the breeder in prioritizing the selection of yield and yield related characters. Correlation coefficient analysis measures the mutual relationship between various plant characters and determines the component characters on which selection can be based for improvement in yield" [6]. Path analysis permits identification of direct and indirect causes of association and measures the relative importance of each character to a plant breeder for initiating a judicious breeding programme. Hence the present investigation was under taken to study the path co-efficient analysis in sponge gourd genotypes.

2. MATERIALS AND METHODS

The experiment was carried out at the experimental plot of Department of Vegetable Science, College of Horticulture, UHS, Bagalkot (Karnataka) during rabi 2020-2021. The experiment was laid out in a RCBD design with two replications consisting of fourty sponge gourd genotypes collected from different locations. Data was recorded on five randomly selected plants in each of the treatment.

The observations were recorded for 17 quantitative and qualitative traits namely, vine length at harvest, number of branches per vine, days to first female flower, node at first female flower, days to first harvest, fruit length, fruit diameter, average fruit weight, number of fruits per vine, number of seeds per fruit, sponge yield, TSS, ascorbic acid, potassium content, phenol content, crude fiber and fruit yield per vine. The data was analyzed statistically for path-coefficient analysis which was suggested by Wright [7] and elaborated by Dewey and Lu [8].

3. RESULTS AND DISCUSSION

Analysis of correlation indicates the association pattern of component traits with yield. It simply represents the general association of a particular trait with yield rather than providing cause and effect relationship. The technique of path coefficient analysis developed by Wright [7] and demonstrated by Dewey and Lu [8] facilitates partitioning the correlation coefficients into direct and indirect involvement of various component characters on yield. Positive direct effect of this trait on fruit yield per plant is main cause for positive correlation of this trait with yield per plant. Hence, this trait proves to be a reliable character for improvement through selection. In sponge gourd seventeen important growth, yield and quality parameters were subjected to

genotypic and phenotypic path coefficient analysis by considering fruit yield as dependent variable on sixteen other are independent variables.

3.1 Phenotypic Path Co-efficient Analysis

The data pertaining to the phenotypic path co-efficient for different characters of sponge gourd are presented in Table 1. Among all characters studied yield per vine had exhibited positive direct effect through number of fruits per vine (0.721) followed by average fruit weight (0.487), fruit length (0.092), sponge yield (0.080), number of seeds per fruit (0.060), number of branches per vine (0.047), crude fibre content (0.019), ascorbic acid (0.015) and vine length (0.014). Similar impact of these traits on fruit yield per plant was observed by Patidar [9], Sharma *et al.* [10], Yadav *et al.* [11], Kumar *et al.* [12], Parveen *et al.* [13], Annigeri [14] and Purushottama [15] in sponge gourd. Whereas, node at first female flower (-0.098), phenol content (-0.040), days to first female flower (-0.029), TSS (-0.024), fruit diameter (-0.022), days to first harvest (-0.021) and potassium content (-0.011) had negative direct effect (desirable) on fruit yield per vine. Similar negative impact of these parameters was found on fruit yield per vine by Patidar [19], Kumar *et al.* [12], Annigeri [14] and Ray [16] in sponge gourd.

Number of fruits per vine shown positive direct effect on fruit yield per vine (0.721). It also exhibited positive and indirect effect through vine length (0.384), sponge yield (0.329), number of branches per vine (0.293), fruit length (0.228), TSS (0.196), node at first female flower (0.081), number of seeds per fruit (0.061), potassium content (0.026), fruit diameter (0.012) and crude fibre content (0.010). These results are in compliance with the reports of Annigeri [14], Yadav [17] and Purushottama [15] in sponge gourd.

The character number of seeds per fruit exhibited positive direct effect (0.721) on fruit yield per vine through its positive indirect effect of potassium content (0.012), sponge yield (0.011), TSS (0.010), fruit diameter (0.009), crude fibre content (0.009), vine length (0.008), number of fruits per vine (0.005), number of branches per vine (0.004) and fruit length (0.004). These results are similar to the findings of Kumar *et al.* [12] and Purushottama [15] in sponge gourd.

The trait average fruit weight had high positive direct effect (0.487) on fruit yield per vine through its indirect effect of days to first harvest (0.146), days to first female flower (0.180), fruit length (0.112), vine length (0.033), node at first female flower (0.029), phenol content (0.026), number of branches per vine (0.021) and crude fibre content (0.010). Similar results were reported by Yadav *et al.* [11], Annigeri [14] and Purushottama [15] in sponge gourd and Mitu *et al.* [18] in ridge gourd.

Fruit length recorded positive direct effect on fruit yield per vine (0.092) via indirect effect through vine length (0.042), sponge yield (0.040), number of branches per vine (0.034), number of fruits per vine(0.029), average fruit weight (0.021), node at first female flower (0.013), number of seeds per fruit (0.007) and phenol content (0.006). These results are in accordance with the reports of Ray [16] and Purushottama [15] in sponge gourd.

Sponge yield observed positive direct effect (0.080) on fruit yield per vine, while it had positive indirect effect via number of branches per vine (0.040), number of fruits per vine (0.037), vine length (0.036), fruit length (0.035), node at first female flower (0.015), number of seeds per fruit (0.015), TSS (0.015) and potassium content (0.007).

Number of branches per vine showed positive direct effect (0.047) on yield per vine via sponge yield (0.023), number of fruits per vine (0.019), fruit length (0.017), vine length (0.013), potassium content (0.004), number of seeds per fruit (0.003), TSS (0.003) and average fruit weight (0.002). The findings of Kumar *et al*. [1], Singh and Tiwari [19] and Som *et al.* [20] in sponge gourd are in conformity with present findings.

Crude fibre content in fruits had positive direct association with fruit yield per vine (0.019) through its positive indirect effects of fruit diameter (0.006), TSS (0.004), number of fruits per vine (0.003), number of seeds per fruit (0.003), node at first female flower (0.001), ascorbic acid (0.001) and potassium content (0.001).

The vine length had positive and direct effect on fruit yield per vine (0.014) and indirect and positive effect with fruit length (0.006), sponge yield (0.006), number of branches per vine (0.004), node at first female flower (0.003), number of seeds per fruit (0.002), TSS (0.002), average fruit weight (0.001) and potassium content (0.001). Similar results were also

reported by Sharma *et al.* [10], Singh and Tiwari [19], Som *et al.* [20] and Purushottama [15] in sponge gourd.

Ascorbic acid value in fruits reported to had positive but less direct effect (0.015) on fruit yield per vine through its indirect effect of phenol (0.004), fruit diameter (0.003), node at first female flower (0.002), days to first fruit harvest (0.002), potassium content (0.002), days to first female flower (0.001), TSS (0.001) and crude fibre content (0.001).

Days to appearance of first female flower had negative direct impact (-0.029) on yield per vine through indirect effect of average fruit weight (-0.011), phenol content (-0.004), fruit diameter (-0.003) and ascorbic acid (-0.002). Whereas, node at first female flower appearance had exerted negative direct effect on yield per vine (-0.098) but it also had negative and indirect effect (which is desirable) via days to first female flower (-0.004), number of seeds per fruit (-0.003), fruit diameter (-0.002), phenol content (-0.002) and TSS (-0.001). These results are similar with Ray [16].

Days to first harvest had negative direct impact (-0.021) on yield per vine through indirect negative effect of vine length (-0.009), number of fruits per vine (-0.009), sponge yield (-0.009), fruit length (-0.005), number of branches per vine (-0.004), number of seeds per fruit (-0.004), TSS (-0.003), potassium content (-0.004) and crude fibre content (-0.002). These results are in agreement with the findings of Patidar [9], Som *et al.* [20] in sponge gourd and Kumar and Singh [21] in ridge gourd.

Fruit diameter observed negative direct effect on fruit yield per vine (-0.022) but it had very little positive indirect effect via fruit length (0.007), vine length (0.004), phenol content (0.004), number of branches per vine (0.003), sponge yield (0.003), node at first female flower (0.002) and average fruit weight (0.002). These results are in accordance with the results of Patidar [9].

The parameters like TSS (-0.024), potassium content (-0.011) and phenol content in fruits (-0.040) had negative and direct effect on fruit yield per vine.

3.2 Genotypic Path Co-efficient Analysis

Genotypic path coefficient of fruit yield per vine (Table 2) had positive direct effect through number of fruits per vine (1.295) followed by phenol content (0.291), fruit diameter (0.271), average fruit weight (0.258), fruit length (0.219), number of branches per vine (0.159), TSS (0.110) and vine length (0.035). Thus the higher magnitude of positive direct effect of these traits explains the higher value of association between these traits on yield per vine. Therefore, direct selection for these traits would reward for yield improvement in sponge gourd. Similar impact of these traits on fruit yield per plant was observed by Sharma *et al.* [10], Kumar *et al.* [12], Parveen *et al.* (2019), Annigeri [14] and Purushottama [15] in sponge gourd. While, ascorbic acid (-0.515), node at first female flower (-0.405), sponge yield (-0.305), potassium content (-0.210), crude fibre content (-0.121), days to first harvest (-0.091), number of seeds per fruit (-0.027) and days to first female flower (-0.005) had exhibited negative direct effect on fruit yield per vine. These findings are similar to Kumar *et al.* [12], Annigeri [14] and Ray [16] in sponge gourd.

The character number of fruits per vine exhibited positive direct effect on fruit yield per vine (1.295). It also exhibited positive and indirect effects through vine length (1.109), sponge yield (0.811), number of branches per vine (0.718), fruit length (0.580), node at first female flower (0.466), TSS (0.416), potassium content (0.350), number of seeds per fruit (0.223), ascorbic acid (0.025) and crude fibre content (0.010). These results agree with the findings of Parveen *et al.* [13], Singh *et al*. [22], Annigeri [2] and Ray [18] in sponge gourd.

Fruit length showed positive direct effect on fruit yield per vine (0.219) via indirect effect of vine length (0.129), number of seeds per fruit (0.118), number of branches per vine (0.113), number of fruits per vine(0.098), average fruit weight (0.055), node at first female flower (0.043) and phenol content (0.014). These outcomes concur with the findings of Purushottama [15] in sponge gourd, Ramesh *et al.* [23], Gowda [24] and Vijayakumar *et al*. [25] in ridge gourd.

Fruit diameter had positive direct impact on fruit yield per vine (0.271) but it had indirect positive effects through via crude fibre content (0.099), TSS (0.079), potassium content (0.075) number of seeds per fruit (0.065), ascorbic acid (0.064), days to first female flower (0.047) and days to first harvest (0.008). These results are consistent with the conclusions of Yadav *et al.* [11] and Som *et al.* [20] in sponge gourd.

Table 1. Phenotypic path coefficient analysis for yield and its attributing characters in sponge gourd genotypes

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	rP
X_1	**0.014**	0.004	-0.004	-0.063	-0.005	0.006	-0.003	0.001	0.007	0.002	0.006	0.002	-0.001	0.001	-0.002	-0.001	0.532**
X_2	0.013	**0.047**	-0.012	-0.161	-0.007	0.017	-0.006	0.002	0.019	0.003	0.023	0.003	-0.010	0.004	-0.006	-0.003	0.453*
X_3	0.009	0.007	**-0.029**	0.005	0.023	0.008	-0.003	-0.011	0.011	0.005	0.012	0.003	-0.002	0.004	-0.004	0.003	-0.206
X_4	0.001	0.005	-0.004	**-0.098**	0.001	0.003	-0.002	0.001	0.003	-0.003	0.004	-0.001	0.003	0.004	-0.002	0.002	-0.178
X_5	-0.009	-0.004	0.017	0.001	**-0.021**	-0.005	0.001	0.007	-0.009	-0.004	-0.009	-0.003	0.003	-0.004	0.004	-0.002	-0.210
X_6	0.042	0.034	-0.027	0.013	-0.020	**0.092**	-0.028	0.021	0.029	0.007	0.040	-0.008	-0.003	-0.006	0.006	-0.005	0.508**
X_7	0.004	0.003	-0.002	0.002	-0.001	0.007	**-0.022**	0.002	0.000	-0.003	0.003	-0.004	-0.005	-0.004	0.004	-0.007	-0.096
X_8	0.033	0.021	0.180	0.029	0.146	0.112	-0.052	**0.487**	-0.044	-0.108	-0.017	-0.105	-0.103	-0.146	0.026	0.010	0.434*
X_9	0.384	0.293	-0.279	0.081	-0.281	0.228	0.012	-0.065	**0.721**	0.061	0.329	0.196	-0.004	0.150	-0.213	0.115	0.784**
X_{10}	0.008	0.004	-0.009	-0.007	-0.011	0.004	0.009	-0.013	0.005	**0.060**	0.011	0.010	-0.008	0.012	-0.007	0.009	0.033
X_{11}	0.036	0.040	-0.035	0.015	-0.032	0.035	-0.011	-0.003	0.037	0.015	**0.080**	0.015	-0.018	0.007	-0.023	-0.009	0.484*
X_{12}	-0.004	-0.001	0.002	0.001	0.003	0.002	-0.005	0.005	-0.007	-0.004	-0.004	**-0.024**	-0.002	-0.004	0.006	-0.005	0.097
X_{13}	-0.001	-0.003	0.001	0.002	0.002	-0.001	0.003	-0.003	0.000	-0.002	-0.003	0.001	**0.015**	0.002	0.004	0.001	-0.146
X_{14}	-0.001	-0.001	0.001	-0.002	0.002	0.001	-0.002	0.003	-0.002	-0.002	-0.001	-0.002	-0.002	**-0.011**	0.000	-0.001	0.011
X_{15}	0.005	0.005	-0.006	0.003	-0.007	-0.003	0.007	-0.002	0.012	0.005	0.011	0.009	-0.010	0.001	**-0.040**	0.006	-0.250
X_{16}	-0.001	-0.001	-0.002	0.001	-0.001	-0.001	0.006	0.000	0.003	0.003	-0.002	0.004	0.001	0.001	-0.003	**0.019**	0.133

*rP = dependent character Diagonal values indicates direct effect Residual effect=0.305 *Indicates significant at p=0.05 **Indicates significant at p=0.01*

X_1= Vine length at harvest; X_2= Number of branches per vine; X_3= Days to first female flower; X_4= Node at first female flower; X_5= Days to first harvest; X_6= Fruit length; X_7= Fruit diameter; X_8= Average fruit weight; X_9= Number of fruits per vine; X_{10}= No. of seeds per fruit; X_{11}= Sponge yield; X_{12}= TSS; X_{13}= Ascorbic acid; X_{14}=Potassium content; X_{15}= Phenol content; X_{16}= Crude fiber

Table 2. Genotypic path coefficient analysis for yield and its attributing characters in sponge gourd genotypes

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	rG
X_1	**0.035**	-0.023	0.014	0.004	0.019	-0.022	0.003	-0.003	-0.031	-0.007	-0.028	-0.012	0.003	-0.004	0.006	0.002	0.769**
X_2	-0.099	**-0.159**	0.078	-0.119	0.084	-0.082	0.037	-0.009	-0.088	-0.008	-0.104	0.002	0.032	-0.014	0.024	0.018	0.564**
X_3	0.002	0.002	**-0.005**	0.002	-0.006	0.002	-0.001	-0.002	0.003	0.001	0.003	0.001	0.000	0.001	-0.001	0.001	-0.248*
X_4	-0.026	0.196	-0.102	**-0.405**	-0.025	0.052	-0.066	0.034	0.136	-0.056	0.087	0.018	0.068	0.113	-0.054	0.013	-0.437*
X_5	-0.090	-0.091	0.213	-0.016	**-0.091**	-0.071	0.005	0.080	-0.110	-0.049	-0.112	-0.076	0.030	-0.049	0.045	-0.029	-0.328*
X_6	0.129	0.113	-0.085	0.043	0.171	**0.219**	-0.079	0.055	0.098	0.027	0.118	-0.028	-0.018	-0.024	0.014	-0.012	0.555**
X_7	-0.019	-0.063	0.047	-0.068	0.008	-0.098	**0.271**	-0.039	-0.012	0.065	-0.052	0.079	0.064	0.075	-0.058	0.099	-0.127
X_8	0.024	0.014	0.116	0.033	0.120	0.065	-0.037	**0.258**	-0.027	-0.060	-0.009	-0.074	-0.068	-0.079	0.014	0.005	0.439*
X_9	1.109	0.718	-0.759	0.466	-0.834	0.580	-0.057	-0.133	**1.295**	0.223	0.811	0.416	0.025	0.350	-0.454	0.223	0.914**
X_{10}	-0.005	-0.001	0.005	0.006	0.008	-0.003	-0.007	0.006	-0.005	**-0.027**	-0.006	-0.008	0.004	-0.006	0.003	-0.005	0.048
X_{11}	-0.236	-0.198	0.164	-0.101	0.199	-0.164	0.059	0.011	-0.191	-0.066	**-0.305**	-0.079	0.113	-0.033	0.091	0.045	0.531**
X_{12}	-0.037	-0.001	-0.030	0.008	-0.049	-0.014	0.032	-0.032	0.036	0.030	0.029	**0.110**	0.014	0.022	-0.033	0.025	0.130
X_{13}	0.045	0.105	-0.009	-0.134	-0.090	0.043	-0.122	0.136	-0.010	0.077	0.192	-0.066	**-0.515**	-0.114	-0.165	-0.052	-0.213*
X_{14}	-0.021	-0.018	0.039	-0.090	0.060	0.023	-0.058	0.064	-0.057	-0.045	-0.022	-0.041	-0.046	**-0.210**	0.005	-0.017	0.012
X_{15}	-0.051	-0.044	0.051	-0.059	0.076	0.019	-0.062	0.016	-0.102	-0.035	-0.087	-0.087	0.093	-0.007	**0.291**	-0.048	-0.250*
X_{16}	0.008	0.014	0.014	-0.006	0.020	0.007	-0.044	-0.003	-0.021	-0.022	0.018	-0.027	-0.012	-0.010	0.020	**-0.121**	0.147

*rG = dependent character Diagonal values indicates direct effect Residual effect=0.209 *Indicates significant at p=0.05 **Indicates significant at p=0.01*

X_1= Vine length at harvest; X_2= Number of branches per vine; X_3= Days to first female flower; X_4= Node at first female flower; X_5= Days to first harvest; X_6= Fruit length; X_7= Fruit diameter; X_8= Average fruit weight; X_9= Number of fruits per vine ; X_{10}= No. of seeds per fruit; X_{11}= Sponge yield; X_{12}= TSS; X_{13}= Ascorbic acid; X_{14}=Potassium content; X_{15}= Phenol content; X_{16}= Crude fiber

Average fruit weight had positive direct effect on fruit yield per vine (0.258) through its indirect effects of days to first harvest (0.120), days to first female flower (0.116), fruit length (0.065), node at first female flower (0.033), vine length (0.024), number of branches per vine (0.014), phenol content (0.014) and crude fibre content (0.005). Singh and Tiwari [19], Kumar *et al.* [12], Annigeri [14], Yadav [17] and Ray [16] also obtained the similar results in sponge gourd.

The trait, number of branches per vine showed positive direct effect on fruit yield per vine (0.196) via days to first harvest (0.084), days to first female flower (0.078), fruit diameter (0.037), ascorbic acid (0.032), phenol content (0.024), crude fibre content (0.018) and TSS (0.002). This is similar with the findings of Sharma *et al.* [10] and Purushottama [15].

The vine length had positive and direct effect on fruit yield per vine (0.035) but it had indirect positive effect through days to first harvest (0.019), days to first female flower (0.014), phenol content (0.006), node at first female flower (0.004), fruit diameter (0.003), ascorbic acid (0.003) and crude fibre content (0.002). This matches the outcomes of Sharma *et al.* [10] and Purushottama [15] in sponge gourd.

Days to appearance of first female flower indicated negative direct effect on fruit yield per vine (-0.005) through indirect effect of days to first harvest (-0.006), average fruit weight (-0.002), fruit diameter (-0.001) and phenol content (-0.001). These results are similar to Ray [16] in sponge gourd.

Node at first female flower appear exhibits negative direct effect on fruit yield per vine (-0.405) but it also had negative and indirect effect (which is desirable) via number of branches per vine (-0.159), days to first female flower (-0.102), fruit diameter (-0.066), number of seeds per fruit (-0.056), phenol content (-0.054), vine length (-0.026) and days to first harvest (-0.025) which is agreement with the findings of Patidar [9].

The character days to first fruit harvest reported to have negative direct effect on yield per vine (-0.091) through indirect effects of sponge yield (-0.112), number of fruits per vine (-0.110), number of branches per vine (-0.091), vine length (-0.090), TSS (-0.076), number of seeds per fruit (-0.049), potassium content (-0.049), crude fibre content (-0.029) and node at first female flower (-0.016). Som *et al.* [20] also obtained the similar results.

Number of seeds per fruit indicated negative direct effect on fruit yield per vine (-0.027) while it had positive indirect effects through days to first harvest (0.008), node at first female flower (0.006), average fruit weight (0.006), days to first female flower (0.005), ascorbic acid (0.004) and phenol content (0.003). These findings are similar to Ahmed *et al*. [26] in ridge gourd.

TSS (0.110) and Phenol content (0.291) had positive direct effect on fruit yield per plant while the ascorbic acid content in fruits (-0.515), sponge yield (-0.305), potassium content (-0.210), crude fibre content (-0.121) had negative direct effect on fruit yield per plant.

4. CONCLUSION

Path co-efficient analysis is considered as one of the best statistical methods which can help breeders to characterize the genotypes during the parent selection program and select the desirable genotypes for higher yield production. The results of the current study exhibit that various traits such as number of fruits per vine, average fruit weight, fruit length, number of branches per vine and vine length can be used to create high yielding sponge gourd varieties under breeding or crop improvement programs.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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