



# Trait Association and Path Analyses for Yield and Its Attributes in Ridge Gourd Commercial Hybrids (*Luffa acutangula* L.)

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## Authors' contributions

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

## Article Information

DOI: <https://doi.org/10.9734/jabb/2024/v27i6944>

## Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/117550>

**Original Research Article**

**Received: 18/03/2024**

**Accepted: 22/05/2024**

**Published: 29/05/2024**

## ABSTRACT

This study aims to explore the relationship between several traits among 18 ridge gourd hybrids. It was carried out during the rabi season of 2021–2022, at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, U.T. of Puducherry. Twenty yield-related qualities were

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**Cite as:** Suvedha M., Marichamy M.S., Kanthaswamy V., Vengadessan V., and Jyothsna J. 2024. "Trait Association and Path Analyses for Yield and Its Attributes in Ridge Gourd Commercial Hybrids (*Luffa Acutangula* L.)". *Journal of Advances in Biology & Biotechnology* 27 (6):812-23. <https://doi.org/10.9734/jabb/2024/v27i6944>.

assessed using a randomized block design with two replications in order to determine the associations among various characters. The yield per vine was found to have a highly significant and positive correlation with the following variables: vine length at final harvest, number of primary branches vine<sup>-1</sup>, number of female flowers vine<sup>-1</sup>, days to final harvest, fruit length, fruit girth, number of seeds fruit<sup>-1</sup>, total number of harvest, number of fruits vine<sup>-1</sup> and weight of individual fruit. Path analysis revealed that the characters such as number of female flowers vine<sup>-1</sup>, days to first female flower anthesis, total number of harvest, sex ratio, total soluble solids, days to first male flower anthesis, vine length at final harvest, number of seeds fruit<sup>-1</sup>, days to first harvest, number of primary branches vine<sup>-1</sup>, fruit length, fruit girth, number of seeds fruit<sup>-1</sup>, number of fruits vine<sup>-1</sup> and weight of individual fruit are considered as important traits which directly and indirectly influences towards yield. It implies that the characters strongly influence the yield vine<sup>-1</sup> and hence selection for these traits would be considered important in selection of hybrids for yield.

**Keywords:** Ridge gourd; correlation coefficient; direct and indirect effects.

## 1. INTRODUCTION

“Ridge gourd (*Luffa acutangula* (L.) Roxb.) belongs to the family Cucurbitaceae and genus *Luffa*. Its chromosome number is  $2n=2x=26$ . It is also called as angled gourd, angled loofah, Chinese okra, silky gourd and ribbed gourd” [1]. “Gourds are the important vegetables in the human diet especially in India. The tender green or immature fruits are cooked as vegetable and used in preparations of chutney and curries. It is considered to be the old-world species and is native of tropical Africa and South-East Asian region including India. Fruit is demulcent, diuretic and nutritive. The juice of the fresh leaves is dropped into the eyes of children for granular conjunctivitis and also to prevent the eye lids sticking together at nights due to excessive meibomian secretion” [2]. “The leading countries in gourds production are China, India, Ukraine, USA and Egypt. Gourds are the important vegetables in the human diet especially in India. Every 100 g of the edible portion of ridge gourd contains 0.5 g of fibre, 0.5 percent of protein, 0.34 percent of carbohydrate, 37 mg of carotene, 5.0 mg of vitamin C, 18 mg of calcium and 0.5 mg of Iron” [3]. “Ridge gourd is estimated to be cultivated in approximately 9.920 hectares and total production is approximately 3.17 lakh tonnes in India [4]. However, most of the cucurbitaceous vegetables are usually cultivated in relatively small areas for local consumption and hence the reliable statistical data on area and production is lacking. Ridge gourd being monoecious in sex expression can be profitably utilized for the production of F<sub>1</sub> hybrid seeds at cheaper rates, as the monoecious nature of crop eliminates emasculation and higher number of hybrid seeds per cross make it more economical. Further, the crop being cultivated at wider spacing, the hybrid seed rate per hectare for

commercial vegetable cultivation would be low and cost effective” [3].

“The cucurbitaceous vegetables being high volume crops offer greater scope to exploit them by developing high yielding varieties and hybrids to bridge the gap between the availability and requirement. The path analysis was used to study the direct and indirect effects on yield. Yield being a complex character, is composed of several components, some of which affect yield directly while others contribute towards it indirectly. Correlation studies provide an opportunity only to study the magnitude and direction of association of yield with its components and also among various components” [3]. But it is essential to know the direct and indirect effects of different traits on the dependent variable i.e., yield per plant. In plant breeding it is very difficult to have complete knowledge of all component traits of yield. The residual effect permits precise explanation about the pattern of interaction of other possible components of yield.

## 2. MATERIALS AND METHODS

The experimental materials consisted of 18 ridge gourd hybrids of which Ridge Gourd COH-1 used as commercial check hybrid (Table 1). These experimental materials were grown under Randomized Block Design (RBD) with two replications. The experimental soil was clay loam with medium fertility, slightly alkaline in soil reaction (pH 8.01) Five randomly chosen plants each replication were tagged and observations were made for growth, yield, and quality metrics. The seeds were gathered from various sources, planted with a gap of two meters between rows and two meters between plants, and normal horticultural procedures and plant safety

precautions were adhered to consistently. Genes software was used to examine correlation and route analysis for each characteristic.

### 3. RESULTS AND DISCUSSION

#### 3.1 Correlation between Fruit Yield per Vine and Other Traits

The fruit yield vine<sup>-1</sup> in ridge gourd was found to be significant and positively correlated with vine length at final harvest (0.624 and 0.699), number of primary branches vine<sup>-1</sup> (0.484 and 0.569), number of female flowers vine<sup>-1</sup> (0.893 and 0.937), days to final harvest (0.761 and 0.793), fruit length (0.827 and 0.870), fruit girth (0.593 and 0.681), number of seeds fruit<sup>-1</sup> (0.581 and 0.611) total number of harvest (0.731 and 0.862), number of fruits vine<sup>-1</sup> (0.885 and 0.909) and weight of individual fruit (0.864 and 0.882) at both phenotypic and genotypic level (Tables 1 & 2). However, number of male flowers vine<sup>-1</sup> (0.347) showed positive but non-significant association with fruit yield vine<sup>-1</sup> at genotypic level, while at phenotypic level, number of male flowers vine<sup>-1</sup> (0.331) showed positive and significant association with fruit yield vine<sup>-1</sup> (Fig. 1). It implies that the characters strongly influence the yield vine<sup>-1</sup> and hence selection for these traits would be considered important in selection of hybrids for yield. Similar findings have been reported earlier by Ananthan and Krishnamoorthy [5] in ridge gourd, Kalpana et al. [6] in bottle gourd and Yadagiri et al. (2017) in bitter melon, Sampath and Krishnamoorthy [5] and Krishnamoorthy and Avinashgupta [7] in pumpkin, Rajawat et al. [8] in cucumber.

While, the traits viz., vitamin C (0.110 and 0.103) and total soluble solids (0.179 and 0.205) showed positive non-significant association with fruit yield vine<sup>-1</sup> at both genotypic and phenotypic level. The association of characters like days to first male flower anthesis (-0.243 and -0.290), days to first female flower anthesis (-0.144 and -0.127), days to 50 per cent flowering (-0.207 and -0.222), sex ratio (-0.107 and -0.098), days to first harvest (-0.092 and -0.056), 100 seed weight (0.031 and -0.048), crude protein (-0.155 and -0.137) recorded negative and non-significant association with fruit yield vine<sup>-1</sup> at phenotypic as well as genotypic level. Similar findings were reported by Kumar et al. [9] in bottle gourd.

Number of female flowers vine<sup>-1</sup> recorded the highest correlation (r = 0.893) with fruit yield

vine<sup>-1</sup> followed by number of fruits vine<sup>-1</sup> (r = 0.885), weight of individual fruit (r = 0.864) and fruit length (r = 0.827) at phenotypic level. At genotypic level, number of female flowers vine<sup>-1</sup> recorded the highest correlation (r = 0.937) with fruit yield vine<sup>-1</sup> followed by number of fruits vine<sup>-1</sup> (r = 0.909), weight of individual fruit (r = 0.882) and fruit length (r = 0.870).

#### 3.2 Inter Correlation among Important Yield Contributing Characters

The inter correlation among component characters revealed significant and positive association of vine length at final harvest with number of male flowers vine<sup>-1</sup> (0.499 and 0.582), number of female flowers vine<sup>-1</sup> (0.616 and 0.745), days to final harvest (0.668 and 0.796), fruit length (0.501 and 0.574), total number of harvest (0.541 and 0.609), number of fruits vine<sup>-1</sup> (0.723 and 0.796), weight of individual fruit (0.432 and 0.481) and total soluble solids (0.485 and 0.607) at both phenotypic and genotypic level. The trait number of primary branches vine<sup>-1</sup> exhibited positive and significant association with number of female flowers vine<sup>-1</sup> (0.506 and 0.568), fruit length (0.550 and 0.600), number of fruits vine<sup>-1</sup> (0.389 and 0.502) and weight of individual fruit (0.462 and 0.507), while the trait days to first male flowering with days to days to first female flower anthesis (0.377 and 0.482) and the trait days to first female flowering with days to 50 per cent flowering (0.867 and 0.945), days to first harvest (0.581 and 0.891) and crude protein (0.490 and 0.554) both genotypic and phenotypic level.

The trait days to 50 per cent flowering showed positive and significant association with days to first harvest (0.502 and 0.784) and crude protein (0.516 and 0.644) whereas the trait sex ratio associated with number of male flowers vine<sup>-1</sup> (0.714 and 0.735) and the trait number of male flowers vine<sup>-1</sup> exhibited positive and significant association with number of fruits vine<sup>-1</sup> (0.450 and 0.475) and total soluble solids (0.417 and 0.486). The character number of female flowers vine<sup>-1</sup> significant and positively associated with days to final harvest (0.578 and 0.637), fruit length (0.705 and 0.751), number of seeds fruit<sup>-1</sup> (0.518 and 0.555), total number of harvest (0.627 and 0.848), number of fruits vine<sup>-1</sup> (0.840 and 0.880) and weight of individual fruit (0.678 and 0.695) while the trait days to first harvest associated with vitamin C (0.337 and 0.680) and crude protein (0.336 and 0.526). Days to final harvest exhibited positive significant association

with fruit length (0.797 and 0.849), fruit girth (0.565 and 0.635), number of seeds fruit<sup>-1</sup> (0.570 and 0.608), total number of harvest (0.571 and 0.645), number of fruits vine<sup>-1</sup> (0.681 and 0.725), weight of individual fruit (0.786 and 0.821) and total soluble solids (0.403 and 0.539). The trait fruit length showed positively significant association with fruit girth (0.477 and 0.595), number of seeds fruit<sup>-1</sup> (0.490 and 0.553), total number of harvest (0.480 and 0.616), number of fruits vine<sup>-1</sup> (0.615 and 0.658) and weight of individual fruit (0.862 and 0.880), whereas the trait fruit girth had a positive and significant association with number of seeds fruit<sup>-1</sup> (0.580 and 0.657), total number of harvest (0.527 and 0.583) and weight of individual fruit (0.764 and 0.894) (Tables 1 & 2) (Fig. 3).

Positive and significant association was exhibited by number of seeds fruit<sup>-1</sup> with total number of harvest (0.474 and 0.587), number of fruits vine<sup>-1</sup> (0.504 and 0.565) and weight of individual fruit (0.554 and 0.590), while the trait total number of harvest had a positive and significant association with number of fruits vine<sup>-1</sup> (0.779 and 0.938) and weight of individual fruit (0.530 and 0.667), while the trait number of fruits vine<sup>-1</sup> associated with the trait weight of individual fruit (0.609 and 0.625).

At phenotypic level, positive significant association was seen for vine length at final harvest with number of primary branches vine<sup>-1</sup> (0.356), number of seeds fruit<sup>-1</sup> (0.369) while number of primary branches vine<sup>-1</sup> exhibited positive and significant association with days to final harvest (0.369). Days to first female flowering showed positive and significant association with vitamin C (0.366). The trait number of male flowers vine<sup>-1</sup> is associated with number of female flowers vine<sup>-1</sup> (0.413) and the trait number of female flowers vine<sup>-1</sup> with fruit girth (0.391), the trait fruit girth with 100 seed weight (0.337) and number of fruits vine<sup>-1</sup> (0.414). Number of seeds fruit<sup>-1</sup> was positively and significantly associated with 100 seed weight (0.339). At genotypic level, positive significant association was seen for number of primary branches vine<sup>-1</sup> with total number of harvest (0.488), the trait days to first male flowering with days to first harvest (0.614) and the trait days to first harvest with total soluble solids (0.654).

Negative significant correlation was observed for days to first female flowering with number of female flowers vine<sup>-1</sup> (-0.374) at phenotypic level whereas the character days to 50 per cent

flowering with number of female flowers vine<sup>-1</sup> (-0.453 and -0.518) at both phenotypic and genotypic levels. The trait days to first harvest showed negative significant correlation with total number of harvest (-0.347) at phenotypic level. Similar results were reported by Narasannavar et al. [10], Varalakshmi et al. [11], Ananthan and Krishnamoorthy [12], Kannan et al. [13], Vijayakumar et al. [14] in ridge gourd.

### 3.3 Path Analysis

It is appropriate to exercise selection based on other qualities that contribute to yield as well, as it is evident that yield alone may not be a useful criterion for hybrid selection in any crop improvement program. The interrelationships between the components explain the link between yield and its component qualities. The estimates of correlation coefficient revealed only the relationship between yield and yield components. However, path coefficient analysis suggested by Dewey and Lu [15], "is a statistical tool which provides an effective means of partitioning direct and indirect causes of association. Hence, the path analysis was carried out in the present study for all the yield component traits to study the direct and indirect effects of traits on yield. Further, it permits to recognize the specific forces acting to produce a given correlation and measures the relative importance of each causal factor. Such an analysis was carried out in the present study with all yield characters".

### 3.4 Direct Effects

The study of path coefficient analysis for yield and its contributing characters in 18 ridge gourd hybrids revealed the presence of very high direct positive effect of weight of individual fruit (0.9416) on yield vine<sup>-1</sup>. In the present investigation, the characters viz., number of female flowers vine<sup>-1</sup> (0.8451), days to first female flower anthesis (0.5435), total number of harvest (0.3100), sex ratio (0.2317), total soluble solids (0.1994), days to first male flower anthesis (0.1559), vine length at final harvest (0.1475), number of seeds fruit<sup>-1</sup> (0.0404) and days to first harvest (0.0093) were found to register positive direct effect on yield. Similar results was also observed by Kamaladevi [16], Harshitha et al. [17] in ridge gourd, Manikandan et al. [18] in bottle gourd and Gangadhara et al. [19] in cucumber. The direct selections for these characters are likely to bring about an overall improvement in fruit yield vine<sup>-1</sup>. The characters

**Table 1. Phenotypic correlation coefficient in ridge gourd hybrids**

	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>	X <sub>10</sub>	X <sub>11</sub>	X <sub>12</sub>	X <sub>13</sub>	X <sub>14</sub>	X <sub>15</sub>	X <sub>16</sub>	X <sub>17</sub>	X <sub>18</sub>	X <sub>19</sub>	X <sub>20</sub>	X <sub>21</sub>
X <sub>1</sub>	1.000	0.356*	0.003	-0.155	-0.224	0.103	0.499**	0.616**	0.117	0.668**	0.501**	0.234	0.369*	0.046	0.541**	0.723**	0.432**	0.187	-0.230	0.485**	0.624**
X <sub>2</sub>		1.000	-0.042	-0.004	-0.163	-0.146	0.243	0.506**	0.095	0.369*	0.550**	0.156	0.002	-0.207	0.285	0.389*	0.462**	0.096	-0.221	0.163	0.484**
X <sub>3</sub>			1.000	0.377*	0.214	-0.238	-0.095	-0.320	0.277	-0.005	-0.092	-0.326	-0.164	-0.074	-0.249	-0.160	-0.274	-0.288	0.318	-0.104	-0.243
X <sub>4</sub>				1.000	0.867**	-0.065	-0.154	-0.374*	0.581**	0.048	0.026	-0.117	-0.317	0.139	-0.223	-0.108	-0.074	0.366*	0.490**	-0.094	-0.144
X <sub>5</sub>					1.000	0.013	-0.202	-0.45**	0.502**	-0.061	-0.127	0.013	-0.260	0.119	-0.221	-0.172	-0.085	0.317	0.516**	-0.005	-0.207
X <sub>6</sub>						1.000	0.714**	-0.034	0.120	-0.010	-0.166	-0.196	-0.198	-0.200	0.004	0.063	-0.232	0.272	-0.050	0.216	-0.107
X <sub>7</sub>							1.000	0.413*	0.185	0.232	0.218	-0.125	0.018	-0.317	0.187	0.450**	0.104	0.178	-0.242	0.417*	0.331*
X <sub>8</sub>								1.000	-0.192	0.578**	0.705**	0.391*	0.518**	-0.153	0.627**	0.840**	0.678**	-0.027	-0.310	0.166	0.893**
X <sub>9</sub>									1.000	0.163	0.075	-0.088	-0.167	0.153	-0.347*	-0.117	0.003	0.337*	0.336*	0.290	-0.092
X <sub>10</sub>										1.000	0.797**	0.565**	0.570**	0.250	0.571**	0.681**	0.786**	0.142	0.158	0.403*	0.761**
X <sub>11</sub>											1.000	0.477**	0.490**	0.067	0.480**	0.615**	0.862**	0.090	0.001	0.242	0.827**
X <sub>12</sub>												1.000	0.580**	0.337*	0.527**	0.414*	0.764**	0.128	-0.012	0.058	0.593**
X <sub>13</sub>													1.000	0.339*	0.474**	0.504**	0.554**	-0.367*	0.092	0.273	0.581**
X <sub>14</sub>														1.000	0.056	-0.060	0.145	0.092	0.260	0.125	-0.031
X <sub>15</sub>															1.000	0.779**	0.530**	0.201	-0.214	0.005	0.731**
X <sub>16</sub>																1.000	0.609**	0.090	-0.168	0.167	0.885**
X <sub>17</sub>																	1.000	0.150	-0.043	0.244	0.864**
X <sub>18</sub>																		1.000	-0.144	0.034	0.110
X <sub>19</sub>																			1.000	0.091	-0.155
X <sub>20</sub>																				1.000	0.179
X <sub>21</sub>																					1.000

\*Significant at 5 per cent

\*\*Significant at 1 per cent

X<sub>1</sub>- Vine length at final harvest  
 X<sub>2</sub>- Number of primary branches vine<sup>-1</sup>  
 X<sub>3</sub>- Days to first male flower anthesis  
 X<sub>4</sub>- Days to first female flower anthesis  
 X<sub>5</sub>- Days to 50 per cent flowering  
 X<sub>6</sub>- Sex ratio  
 X<sub>7</sub>- Number of male flowers vine<sup>-1</sup>

X<sub>8</sub>- Number of female flowers vine<sup>-1</sup>  
 X<sub>9</sub>- Days to first harvest  
 X<sub>10</sub>- Days to final harvest  
 X<sub>11</sub>- Fruit length  
 X<sub>12</sub>- Fruit girth  
 X<sub>13</sub>- Number of seeds fruit<sup>-1</sup>  
 X<sub>14</sub>- 100 seed weight

X<sub>15</sub>- Total number of harvest  
 X<sub>16</sub>- Number of fruits vine<sup>-1</sup>  
 X<sub>17</sub>- Weight of individual fruit  
 X<sub>18</sub>- Vitamin C  
 X<sub>19</sub>- Crude protein  
 X<sub>20</sub>- Total soluble solids  
 X<sub>21</sub>- Fruit yield vine<sup>-1</sup>

**Table 2. Genotypic correlation coefficient in ridge gourd hybrids**

	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>	X <sub>10</sub>	X <sub>11</sub>	X <sub>12</sub>	X <sub>13</sub>	X <sub>14</sub>	X <sub>15</sub>	X <sub>16</sub>	X <sub>17</sub>	X <sub>18</sub>	X <sub>19</sub>	X <sub>20</sub>	X <sub>21</sub>
X <sub>1</sub>	1.000	0.468	-0.037	-0.127	-0.390	0.167	0.582*	0.745**	0.367	0.796**	0.574*	0.216	0.421	0.068	0.609**	0.796**	0.481*	0.196	-0.266	0.607**	0.699**
X <sub>2</sub>		1.000	0.027	-0.092	-0.288	-0.195	0.266	0.568*	-0.157	0.432	0.600**	0.232	0.019	-0.212	0.488*	0.502*	0.507*	0.141	-0.267	0.161	0.569*
X <sub>3</sub>			1.000	0.482*	0.238	-0.245	-0.098	-0.361	0.614**	0.013	-0.062	-0.432	-0.175	-0.088	-0.373	-0.213	-0.289	-0.325	0.348	-0.135	-0.290
X <sub>4</sub>				1.000	0.945**	-0.110	-0.190	-0.416	0.891**	0.089	0.008	-0.056	-0.327	0.165	-0.127	-0.076	-0.084	0.408	0.554*	-0.110	-0.127
X <sub>5</sub>					1.000	-0.036	-0.273	-0.518*	0.784**	0.022	-0.159	0.100	-0.223	0.157	-0.205	-0.190	-0.103	0.386	0.644**	-0.010	-0.222
X <sub>6</sub>						1.000	0.735**	-0.020	0.043	-0.028	-0.172	-0.241	-0.181	-0.205	0.033	0.069	-0.238	0.310	-0.071	0.306	-0.098
X <sub>7</sub>							1.000	0.417	0.282	0.259	0.226	-0.134	0.016	-0.331	0.236	0.475*	0.105	0.182	-0.237	0.486*	0.347
X <sub>8</sub>								1.000	-0.318	0.637**	0.751**	0.447	0.555*	-0.156	0.848**	0.880**	0.695**	-0.019	-0.315	0.203	0.937**
X <sub>9</sub>									1.000	0.396	0.199	-0.049	-0.286	0.268	-0.255	-0.046	0.028	0.680**	0.526*	0.654**	-0.056
X <sub>10</sub>										1.000	0.849**	0.635**	0.608**	0.263	0.645**	0.725**	0.821**	0.164	0.186	0.539*	0.793**
X <sub>11</sub>											1.000	0.595**	0.553*	0.073	0.616**	0.658**	0.880**	0.091	-0.007	0.232	0.870**
X <sub>12</sub>												1.000	0.657**	0.408	0.583*	0.425	0.894**	0.204	-0.008	0.170	0.681**
X <sub>13</sub>													1.000	0.345	0.587*	0.565*	0.590*	-0.414	0.134	0.366	0.611**
X <sub>14</sub>														1.000	0.087	-0.045	0.152	0.069	0.280	0.172	-0.048
X <sub>15</sub>															1.000	0.938**	0.667**	0.259	-0.167	-0.092	0.862**
X <sub>16</sub>																1.000	0.625**	0.105	-0.178	0.229	0.909**
X <sub>17</sub>																	1.000	0.152	-0.044	0.291	0.882**
X <sub>18</sub>																		1.000	-0.154	0.005	0.103
X <sub>19</sub>																			1.000	0.157	-0.137
X <sub>20</sub>																				1.000	0.205
X <sub>21</sub>																					1.000

\* Significant at 5 per cent

\*\* Significant at 1 per cent

X<sub>1</sub>- Vine length at final harvest  
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 X<sub>3</sub>- Days to first male flower anthesis  
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 X<sub>7</sub>- Number of male flowers vine<sup>-1</sup>

X<sub>8</sub>- Number of female flowers vine<sup>-1</sup>  
 X<sub>9</sub>- Days to first harvest  
 X<sub>10</sub>- Days to final harvest  
 X<sub>11</sub>- Fruit length  
 X<sub>12</sub>- Fruit girth  
 X<sub>13</sub>- Number of seeds fruit<sup>-1</sup>  
 X<sub>14</sub>- 100 seed weight

X<sub>15</sub>- Total number of harvest  
 X<sub>16</sub>- Number of fruits vine<sup>-1</sup>  
 X<sub>17</sub>- Weight of individual fruit  
 X<sub>18</sub>- Vitamin C  
 X<sub>19</sub>- Crude protein  
 X<sub>20</sub>- Total soluble solids  
 X<sub>21</sub>- Fruit yield vine<sup>-1</sup>

**Table 3. Path coefficient showing direct and indirect effects of different traits in ridge gourd hybrids**

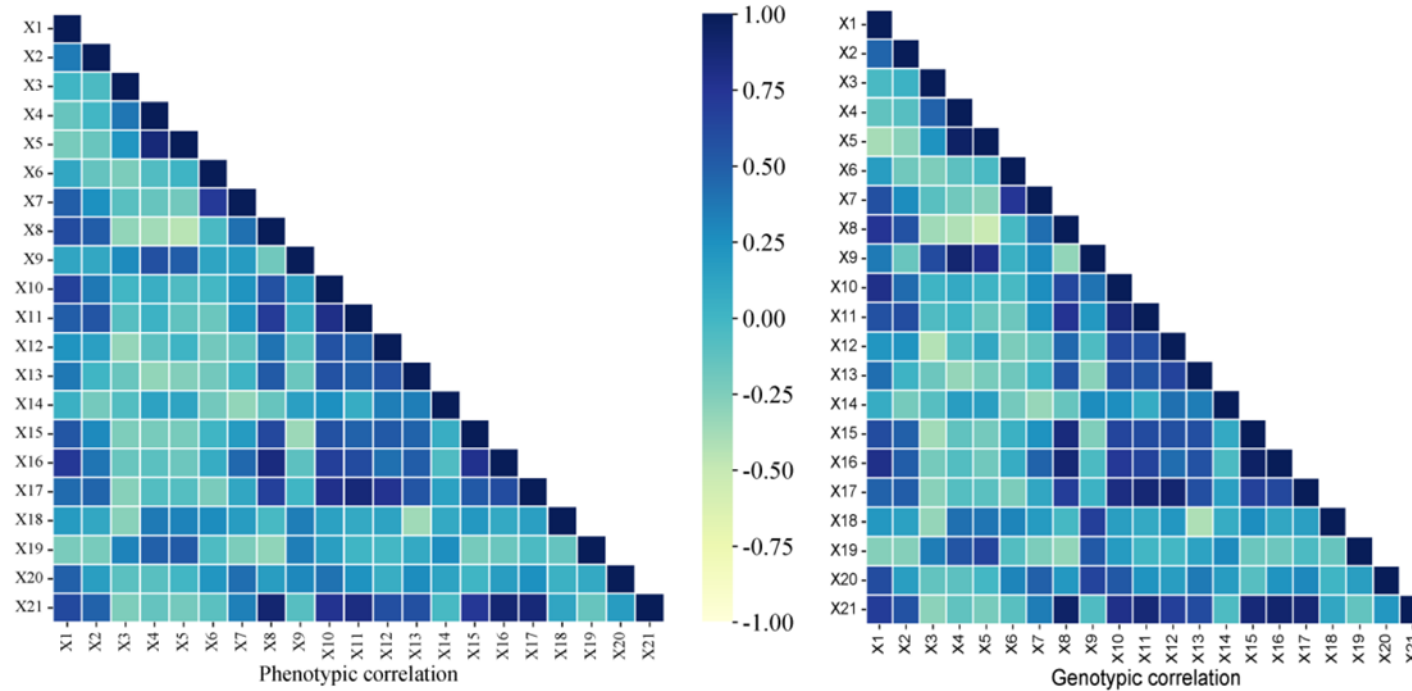
	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	X <sub>8</sub>	X <sub>9</sub>	X <sub>10</sub>	X <sub>11</sub>	X <sub>12</sub>	X <sub>13</sub>	X <sub>14</sub>	X <sub>15</sub>	X <sub>16</sub>	X <sub>17</sub>	X <sub>18</sub>	X <sub>19</sub>	X <sub>20</sub>	R <sub>g</sub> (Y)
X <sub>1</sub>	<b>0.1475</b>	-0.040	-0.0058	-0.0691	0.0569	0.0387	-0.0863	0.6295	0.0034	-0.5059	-0.0771	-0.0115	0.0170	-0.0012	0.1889	-0.1381	0.4530	-0.0246	0.0032	0.1211	0.699**
X <sub>2</sub>	0.0690	<b>-0.086</b>	0.0042	-0.0499	0.0420	-0.0452	-0.0394	0.4800	-0.0015	-0.2744	-0.0806	-0.0123	0.0008	0.0038	0.1512	-0.0871	0.4775	-0.0178	0.0033	0.0321	0.569*
X <sub>3</sub>	-0.005	-0.002	<b>0.1559</b>	0.2621	-0.034	-0.0568	0.0146	-0.3054	0.0057	-0.0085	0.0083	0.0229	-0.0071	0.0016	-0.1155	0.0369	-0.2721	0.0408	-0.0042	-0.0268	-0.290
X <sub>4</sub>	-0.018	0.008	0.0752	<b>0.5435</b>	-0.137	-0.0255	0.0281	-0.3518	0.0083	-0.0563	-0.0011	0.0030	-0.0132	-0.0030	-0.0395	0.0131	-0.0793	-0.0512	-0.0067	-0.0219	-0.127
X <sub>5</sub>	-0.057	0.0250	0.0371	0.5136	<b>-0.145</b>	-0.0083	0.0405	-0.4380	0.0073	-0.0139	0.0214	-0.0053	-0.0090	-0.0028	-0.0635	0.0329	-0.0973	-0.0485	-0.0078	-0.0021	-0.222
X <sub>6</sub>	0.0247	0.016	-0.0382	-0.0599	0.0052	<b>0.2317</b>	-0.1089	-0.0168	0.0004	0.0177	0.0231	0.0128	-0.0073	0.0037	0.0101	-0.0119	-0.2242	-0.0389	0.0009	0.0610	-0.098
X <sub>7</sub>	0.0859	-0.023	-0.0154	-0.1032	0.0399	0.1702	<b>-0.1482</b>	0.3527	0.0026	-0.1644	-0.0303	0.0071	0.0007	0.0059	0.0732	-0.0823	0.0985	-0.0229	0.0029	0.0970	0.347
X <sub>8</sub>	0.1099	-0.049	-0.0563	-0.2262	0.0756	-0.0046	-0.0619	<b>0.8451</b>	-0.0030	-0.4047	-0.1009	-0.0237	0.0224	0.0028	0.2629	-0.1526	0.6548	0.0024	0.0038	0.0406	0.937**
X <sub>9</sub>	0.0542	0.0136	0.0959	0.4843	-0.114	0.0099	-0.0419	-0.2689	<b>0.0093</b>	-0.2514	-0.0267	0.0026	-0.0116	-0.0048	-0.0790	0.0080	0.0261	-0.0856	-0.0064	0.1305	-0.056
X <sub>10</sub>	0.1175	-0.037	0.0021	0.0481	-0.0032	-0.0065	-0.0384	0.5384	0.0037	<b>-0.6352</b>	-0.1141	-0.0337	0.0246	-0.0047	0.2001	-0.1258	0.7735	-0.0206	-0.0023	0.1074	0.793**
X <sub>11</sub>	0.0847	-0.052	-0.0097	0.0046	0.0232	-0.0399	-0.0334	0.6347	0.0019	-0.5392	<b>-0.1344</b>	-0.0316	0.0223	-0.0013	0.1909	-0.1142	0.8287	-0.0114	0.0001	0.0463	0.870**
X <sub>12</sub>	0.0318	-0.020	-0.0673	-0.0303	-0.014	-0.0559	0.0198	0.3775	-0.0005	-0.4033	-0.0800	<b>-0.0531</b>	0.0266	-0.0073	0.1808	-0.0737	0.8420	-0.0257	0.0001	0.0339	0.681**
X <sub>13</sub>	0.0621	-0.001	-0.0273	-0.1779	0.0326	-0.0419	-0.0024	0.4694	-0.0027	-0.3864	-0.0743	-0.0349	<b>0.0404</b>	-0.0062	0.1819	-0.0979	0.5551	0.0521	-0.0016	0.0729	0.611**
X <sub>14</sub>	0.0100	0.0184	-0.0138	0.0898	-0.022	-0.0476	0.0491	-0.1319	0.0025	-0.1671	-0.0098	-0.0217	0.0140	<b>-0.0179</b>	0.0271	0.0078	0.1435	-0.0087	-0.0034	0.0343	-0.048
X <sub>15</sub>	0.0899	-0.042	-0.0581	-0.069	0.0299	0.0075	-0.0350	0.7166	-0.0024	-0.4100	-0.0828	-0.0310	0.0237	-0.0016	<b>0.3100</b>	-0.1627	0.6285	-0.0325	0.0020	-0.0183	0.862**
X <sub>16</sub>	0.1175	-0.043	-0.0332	-0.0411	0.0276	0.0160	-0.0704	0.7435	-0.0004	-0.4607	-0.0884	-0.0225	0.0228	0.0008	0.2907	<b>-0.1735</b>	0.5887	-0.0132	0.0022	0.0457	0.909**
X <sub>17</sub>	0.0710	-0.044	-0.0451	-0.0458	0.0151	-0.0552	-0.0155	0.5876	0.0003	-0.5218	-0.1183	-0.0475	0.0238	-0.0027	0.2069	-0.1085	<b>0.9416</b>	-0.0191	0.0005	0.0580	0.882**
X <sub>18</sub>	0.0289	-0.012	-0.0506	0.2216	-0.0563	0.0718	-0.0270	-0.0160	0.0064	-0.1042	-0.0122	-0.0109	-0.0167	-0.0012	0.0801	-0.0182	0.1430	<b>-0.1257</b>	0.0019	0.0009	0.103
X <sub>19</sub>	-0.039	0.0231	0.0543	0.3009	-0.0939	-0.0164	0.0351	-0.2664	0.0049	-0.1181	0.0010	0.0004	0.0054	-0.0050	-0.0516	0.0309	-0.0413	0.0194	<b>-0.0122</b>	0.0312	-0.137
X <sub>20</sub>	0.0896	-0.014	-0.0210	-0.0597	0.0015	0.0708	-0.0721	0.1719	0.0061	-0.3422	-0.0312	-0.0090	0.0148	-0.0031	-0.0285	-0.0398	0.2738	-0.0006	-0.0019	<b>0.1994</b>	0.205

*Bold values indicate direct effect*      Residual Effect = 0.1643931      R<sub>g</sub>(Y)- Genotypic correlation coefficient with fruit yield vine<sup>1</sup>

X<sub>1</sub>- Vine length at final harvest  
 X<sub>2</sub>- Number of primary branches vine<sup>1</sup>  
 X<sub>3</sub>- Days to first male flower anthesis  
 X<sub>4</sub>- Days to first female flower anthesis  
 X<sub>5</sub>- Days to 50 per cent flowering  
 X<sub>6</sub>- Sex ratio  
 X<sub>7</sub>- Number of male flowers vine<sup>1</sup>

X<sub>8</sub>- Number of female flowers vine<sup>1</sup>  
 X<sub>9</sub>- Days to first harvest  
 X<sub>10</sub>- Days to final harvest  
 X<sub>11</sub>- Fruit length  
 X<sub>12</sub>- Fruit girth  
 X<sub>13</sub>- Number of seeds fruit<sup>1</sup>  
 X<sub>14</sub>- 100 seed weight

X<sub>15</sub>- Number of harvest  
 X<sub>16</sub>- Number of fruits vine<sup>1</sup>  
 X<sub>17</sub>- Weight of individual fruit  
 X<sub>18</sub>- Vitamin C  
 X<sub>19</sub>- Crude protein  
 X<sub>20</sub>- Total soluble solids



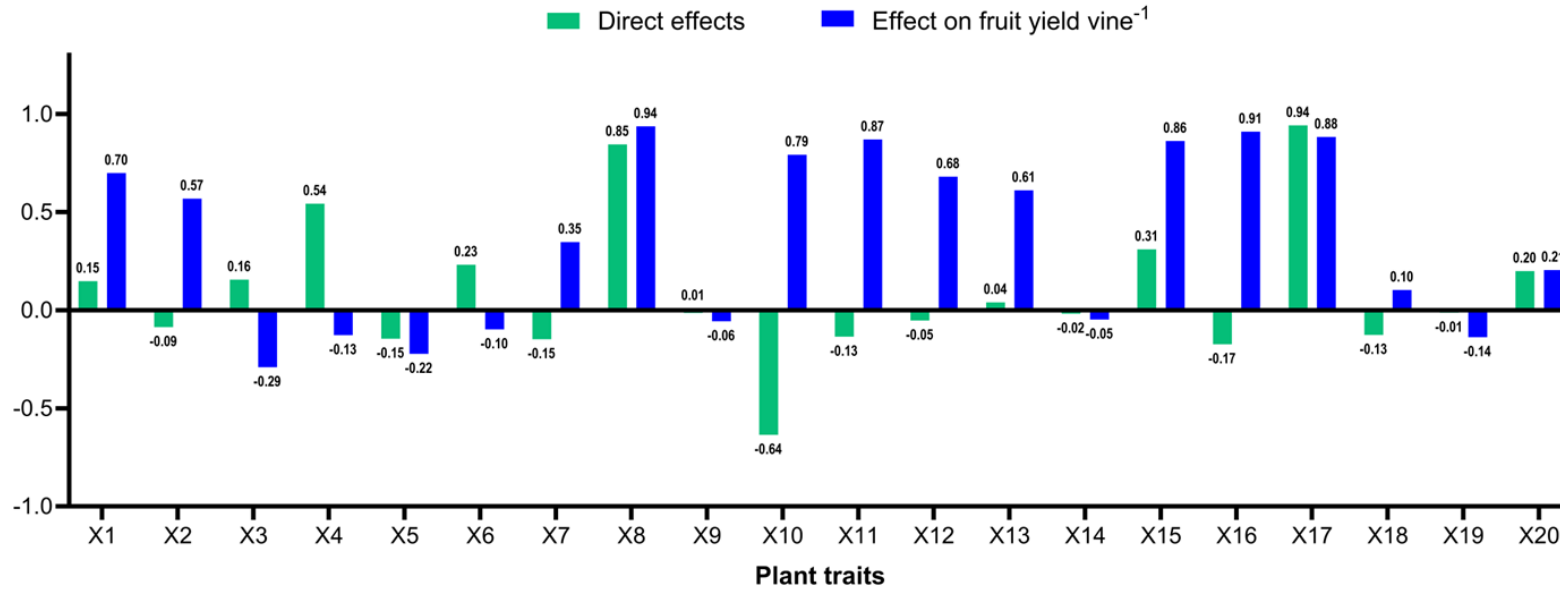
**Fig. 1. Phenotypic and genotypic correlation coefficients in 18 ridge gourd hybrids**

*X*<sub>1</sub>- Vine length at final harvest  
*X*<sub>2</sub>- Number of primary branches vine<sup>-1</sup>  
*X*<sub>3</sub>- Days to first male flower anthesis  
*X*<sub>4</sub>- Days to first female flower anthesis  
*X*<sub>5</sub>- Days to 50 percent flowering  
*X*<sub>6</sub>- Sex ratio  
*X*<sub>7</sub>- Number of male flowers vine<sup>-1</sup>

*X*<sub>8</sub>- Number of female flowers vine<sup>-1</sup>  
*X*<sub>9</sub>- Days to first harvest  
*X*<sub>10</sub>- Days to final harvest  
*X*<sub>11</sub>- Fruit length  
*X*<sub>12</sub>- Fruit girth  
*X*<sub>13</sub>- Number of seeds fruit<sup>-1</sup>  
*X*<sub>14</sub>- 100 seed weight

*X*<sub>15</sub>- Total number of harvest  
*X*<sub>16</sub>- Number of fruits vine<sup>-1</sup>  
*X*<sub>17</sub>- Weight of individual fruit  
*X*<sub>18</sub>- Vitamin C  
*X*<sub>19</sub>- Crude protein  
*X*<sub>20</sub>- Total soluble solids



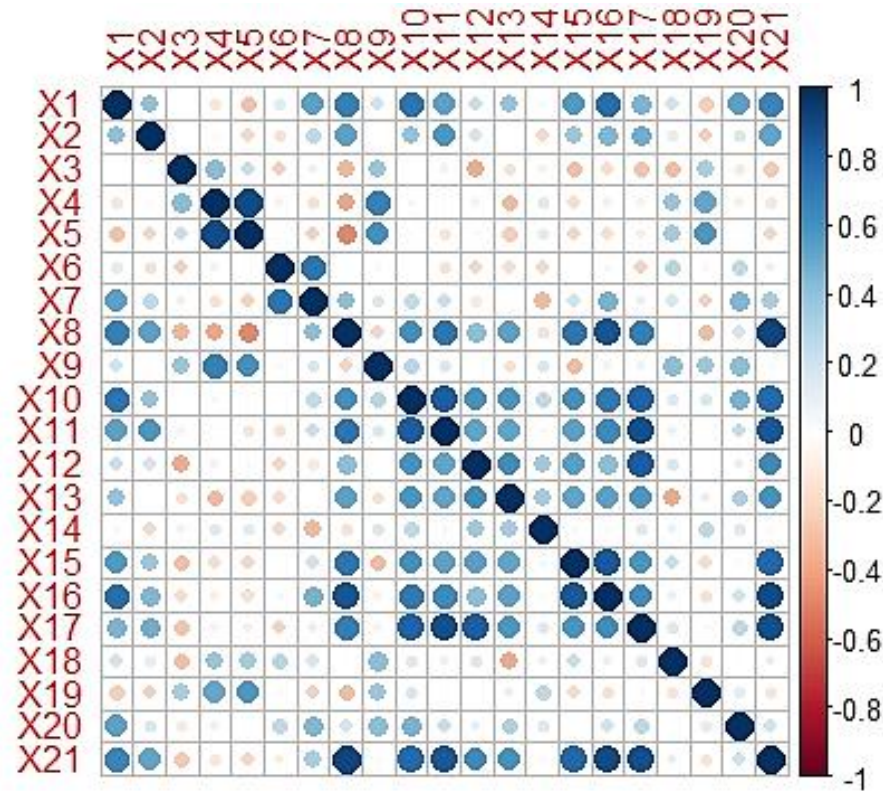


**Fig. 2. Direct effects of component traits and on fruit yield vine<sup>-1</sup> of 18 ridge gourd hybrids**

X<sub>1</sub>- Vine length at final harvest  
 X<sub>2</sub>- Number of primary branches vine<sup>-1</sup>  
 X<sub>3</sub>- Days to first male flower anthesis  
 X<sub>4</sub>- Days to first female flower anthesis  
 X<sub>5</sub>- Days to 50 per cent flowering  
 X<sub>6</sub>- Sex ratio  
 X<sub>7</sub>- Number of male flowers vine<sup>-1</sup>

X<sub>8</sub>- Number of female flowers vine<sup>-1</sup>  
 X<sub>9</sub>- Days to first harvest  
 X<sub>10</sub>- Days to final harvest  
 X<sub>11</sub>- Fruit length  
 X<sub>12</sub>- Fruit girth  
 X<sub>13</sub>- Number of seeds fruit<sup>-1</sup>  
 X<sub>14</sub>- 100 seed weight

X<sub>15</sub>- Number of harvest  
 X<sub>16</sub>- Number of fruits vine<sup>-1</sup>  
 X<sub>17</sub>- Weight of individual fruit  
 X<sub>18</sub>- Vitamin C  
 X<sub>19</sub>- Crude protein  
 X<sub>20</sub>- Total soluble solids



**Fig. 3. Correlation plot showing degree of correlation between traits in ridge gourd hybrids**

X<sub>1</sub>- Vine length at final harvest  
 X<sub>2</sub>- Number of primary branches vine<sup>-1</sup>  
 X<sub>3</sub>- Days to first male flower anthesis  
 X<sub>4</sub>- Days to first female flower anthesis  
 X<sub>5</sub>- Days to 50 percent flowering  
 X<sub>6</sub>- Sex ratio  
 X<sub>7</sub>- Number of male flowers vine<sup>-1</sup>

X<sub>8</sub> - Number of female flowers vine<sup>-1</sup>  
 X<sub>9</sub> - Days to first harvest  
 X<sub>10</sub>- Days to final harvest  
 X<sub>11</sub>- Fruit length  
 X<sub>12</sub>- Fruit girth  
 X<sub>13</sub>- Number of seeds fruit<sup>-1</sup>  
 X<sub>14</sub>- 100 seed weight

X<sub>15</sub>- Total number of harvest  
 X<sub>16</sub>- Number of fruits vine<sup>-1</sup>  
 X<sub>17</sub>- Weight of individual fruit  
 X<sub>18</sub>- Vitamin C  
 X<sub>19</sub>- Crude protein  
 X<sub>20</sub>- Total soluble solids  
 X<sub>21</sub>- Fruit yield vine<sup>-1</sup>

viz., days to final harvest (-0.6352), number of fruits vine<sup>-1</sup> (-0.1735), number of male flowers vine<sup>-1</sup> (-0.1482), days to 50 per cent flowering (-0.1459), fruit length (-0.1344), vitamin C (-0.1257), number of primary branches vine<sup>-1</sup> (-0.0867), fruit girth (-0.0531), 100 seed weight (-0.0179) and crude protein (-0.0122) had registered negative direct effect on fruit yield vine<sup>-1</sup> (Table 3) (Fig 2). Chithra et al. [20] reported through a path coefficient analysis on 40 sponge gourd genotypes that the fruits vine<sup>-1</sup>, fruit weight and length, branches vine<sup>-1</sup> and vine length had positive effects on fruit yield vine<sup>-1</sup>. This result is also in line with the findings of Hemant and Ajay [21], Rajawat et al. [8] and Kalpana et al. [6] in cucurbits. Therefore, a direct selection on these traits would be rewarding in yield improvement programs of ridge gourd.

### 3.5 Indirect Effects

Positive indirect effect of very high magnitude was exerted on yield by vine length at final harvest, number of primary branches vine<sup>-1</sup>, number of female flowers vine<sup>-1</sup>, days to final harvest, fruit length, fruit girth, number of seeds fruit<sup>-1</sup>, total number of harvest, number of fruits vine<sup>-1</sup> and weight of individual fruit. It indicated that these traits are important in selecting high yielding hybrids. Similar to our results, Chauhan et al. [22] reported indirect and positive effects of vine length, branches vine<sup>-1</sup>, days to first flowering, node of first female flower, fruits vine<sup>-1</sup>, TSS and vitamin C on fruit yield vine<sup>-1</sup>.

### 4. CONCLUSION

The association analysis suggests that intentional selection for fruit length, fruit girth, number of seeds, number of fruits, total number of harvest, number of primary branches, number of female flowers, days to final harvest, and weight of individual fruit may all contribute to the simultaneous improvement of fruit yield (vine 1). It is also evident that these traits are very dependable predictors of fruit production and that they might be used as yield markers in selection processes. However, the important characters days to first male flower anthesis, days to first female flower anthesis, days to 50 per cent flowering, sex ratio and days to first harvest were negatively associated with fruit yield vine<sup>-1</sup>.

### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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