TRAIT ASSOCIATION AND PATH ANALYSES FOR YIELD AND ITS ATTRIBUTES IN RIDGE GOURD COMMERCIAL HYBRIDS (*Luffa acutangula* L.)

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 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^{-1}, number of female flowers vine^{-1}, days to final harvest, fruit length, fruit girth, number of seeds fruit^{-1}, total number of harvest, number of fruits vine^{-1} and weight of individual fruit. Path analysis revealed that the characters such as number of female flowers vine^{-1}, 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^{-1}, days to first harvest, number of primary branches vine^{-1}, fruit length, fruit girth, number of seeds fruit^{-1}, number of fruits vine^{-1} 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^{-1} 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

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 (Muthaiah *et al*., 2017). 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 (Rahman *et al*., 2008). 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 (Hazra and Som, 2005). Ridge gourd is estimated to be cultivated in approximately 9.920 hectares and total production is approximately 3.17 lakh tonnes in India (Anonymous, 2017).

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_1 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.

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. 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.

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) A total of five plants under each replication was selected at random and tagged for recording observations for growth, yield and quality parameters. The seeds are collected from different sources, were sown with the spacing of 2 m between rows and 2.0 m between plants and standard horticultural practices and plant protection measures were followed uniformly.Correlation and path analysis for all the traits were analyzed using computer software Genres.

Results and Discussion

Correlation between fruit yield per vine and other traits

The fruit yield vine^{-1} 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^{-1} (0.484 and 0.569), number of female flowers vine^{-1} (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^{-1} (0.581 and 0.611) total number of harvest (0.731 and 0.862), number of fruits vine^{-1} (0.885 and 0.909) and weight of individual fruit (0.864 and 0.882) at both phenotypic and genotypic level (Table 1 & 2). However, number of male flowers vine^{-1} (0.347) showed positive but non-significant association with fruit yield vine^{-1} at genotypic level, while at phenotypic level, number of male flowers vine^{-1} (0.331)showed positive and significant association with fruit yield vine^{-1} (Fig 1). It implies that the characters strongly influence the yield vine^{-1} 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 (2017) in ridge gourd, Kalpana *et al.* (2019) in bottle gourd and Yadagiri *et al.* (2017) in bitter gourd, Sampath and Krishnamoorthy (2017) and Krishnamoorthy and Avinashgupta(2021) in pumpkin, Rajawat *et al.* (2018) 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^{-1} 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^{-1} at phenotypic as well as genotypic level. Similar findings were reported by Kumar *et al*. (2012) in bottle gourd.

Number of female flowers vine^{-1} recorded the highest correlation (r = 0.893) with fruit yield vine^{-1} followed by number of fruits vine^{-1} (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^{-1} recorded the highest correlation (r = 0.937) with fruit yield vine^{-1} followed by number of fruits vine^{-1} (r = 0.909), weight of individual fruit (r = 0.882) and fruit length (r = 0.870).

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^{-1} (0.499 and 0.582), number of female flowers vine^{-1} (0.616 and 0.745), days to final harvest (0.668 and 0.0.796), fruit length (0.501 and 0.574), total number of harvest (0.541 and 0.609), number of fruits vine^{-1} (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^{-1} exhibited positive and significant association with number of female flowers vine^{-1} (0.506 and 0.568), fruit length (0.550 and 0.600), number of fruits vine^{-1} (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^{-1} (0.714 and 0.735) and the trait number of male flowers vine^{-1} exhibited positive and significant association with number of fruits vine^{-1} (0.450 and 0.475) and total soluble solids (0.417 and 0.486). The character number of female flowers vine^{-1} 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^{-1} (0.518 and

0.555), total number of harvest (0.627 and 0.848), number of fruits vine^{-1} (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^{-1} (0.570 and 0.608), total number of harvest (0.571 and 0.645), number of fruits vine^{-1} (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^{-1} (0.490 and 0.553), total number of harvest (0.480 and 0.616), number of fruits vine^{-1} (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^{-1} (0.580 and 0.657), total number of harvest (0.527 and 0.583) and weight of individual fruit (0.764 and 0.894) (Table 1 & 2) (Fig 3).

Positive and significant association was exhibited by number of seeds fruit^{-1} with total number of harvest (0.474 and 0.587), number of fruits vine^{-1} (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^{-1} (0.779 and 0.938) and weight of individual fruit (0.530 and 0.667), while the trait number of fruits vine^{-1} 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^{-1} 0.356), number of seeds fruit^{-1} (0.369) while number of primary branches vine^{-1} 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^{-1} is associated with number of female flowers vine^{-1} (0.413) and the trait number of female flowers vine^{-1} with fruit girth (0.391), the trait fruit girth with 100 seed weight (0.337) and number of fruits vine^{-1} (0.414). Number of seeds fruit^{-1} 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^{-1} 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^{-1} (-0.374) at phenotypic level whereas the character days to 50 per cent flowering with number of female flowers vine^{-1} (-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*. (2014b), Varalakshmi *et al.* (2015), Ananthan and Krishnamoorthy (2017), Kannan *et al*. (2019), Vijayakumar *et al.* (2020) in ridge gourd.

Path analysis

As it is very clear that selection of hybrids based on yield alone may not be effective in any crop improvement programme, exercising selection based on other yield contributing traits as well, is considered reasonable. The association between yield and its component traits are due to inter relationship existing among the components. The estimates of correlation coefficient revealed only the relationship between yield and yield components. However, path coefficient analysis suggested by Dewey and Lu (1959), 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.

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^{-1}. In the present investigation, the characters *viz.,* number of female flowers vine^{-1} (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^{-1} (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 (2012), Harshitha *et al.* (2019) in ridge gourd, Manikandan *et al.* (2017) in bottle gourd and Gangadhara *et al.* (2019) in cucumber. The direct selections for these characters are likely to bring about an overall improvement in fruit yield vine^{-1}. The characters *viz.,* days to final harvest (-0.6352), number of fruits vine^{-1} (-0.1735), number of male flowers vine^{-1} (-0.1482), days to 50 per cent flowering (-0.1459), fruit length (-0.1344), vitamin C (-0.1257), number of primary branches vine^{-1} (-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^{-1} (Table 3) (Fig 2). This result is in line with the findings of Hemant and Ajay (2018), Rajawat *et al.* (2018) and Kalpana *et al.* (2019).

Indirect effects

Positive indirect effect of very high magnitude was exerted on yield by vine length at final harvest, number of primary branches vine^{-1}, number of female flowers vine^{-1}, days to final harvest, fruit length, fruit girth, number of seeds fruit^{-1}, total number of harvest, number of fruits vine^{-1} and weight of individual fruit. It indicated that these traits are important in selecting high yielding hybrids.

Conclusion

It could be concluded from the association analysis that, intentional selection for vine length at final harvest, number of primary branches vine^{-1}, number of female flowers vine^{-1}, days to final harvest, fruit length, fruit girth, number of seeds fruit^{-1}, total number of harvest, number of fruits vine^{-1} and weight of individual fruit may result in simultaneous improvement of fruit yield vine^{-1}. Further, it is clearly indicated that these characters are highly reliable components of fruit yield and could very well be utilized as yield indicator while exercising selection. 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^{-1}. Hence, intensive selection for these traits will however result in the reduction of fruit yield and so compromise towards selection is required for these traits.

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Table 1. Phenotypic correlation coefficient in ridge gourd hybrids

	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}	X_{17}	X_{18}	X_{19}	X_{20}	X_{21}
X_1	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_2		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_3			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_4				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_5					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_6						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_7							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_8								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_9									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_{10}										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_{11}											1.000	0.477**	0.490**	0.067	0.480**	0.615**	0.862**	0.090	0.001	0.242	0.827**
X_{12}												1.000	0.580**	0.337*	0.527**	0.414*	0.764**	0.128	-0.012	0.058	0.593**
X_{13}													1.000	0.339*	0.474**	0.504**	0.554**	-0.367*	0.092	0.273	0.581**
X_{14}														1.000	0.056	-0.060	0.145	0.092	0.260	0.125	-0.031
X_{15}															1.000	0.779**	0.530**	0.201	-0.214	0.005	0.731**
X_{16}																1.000	0.609**	0.090	-0.168	0.167	0.885**
X_{17}																	1.000	0.150	-0.043	0.244	0.864**
X_{18}																		1.000	-0.144	0.034	0.110
X_{19}																			1.000	0.091	-0.155
X_{20}																				1.000	0.179
X_{21}																					1.000

*Significant at 5 per cent ** Significant at 1 per cent

X_1- Vine length at final harvest
X_2- Number of primary branches vine^{-1}
X_3- Days to first male flower anthesis
X_4- Days to first female flower anthesis
X_5- Days to 50 per cent flowering
X_6- Sex ratio
X_7- Number of male flowers vine^{-1}
X_8- Number of female flowers vine^{-1}
X_9- Days to first harvest
X_{10}- Days to final harvest
X_{11}- Fruit length
X_{12}- Fruit girth
X_{13}- Number of seeds fruit^{-1}
X_{14}- 100 seed weight
X_{15}- Total number of harvest
X_{16}- Number of fruits vine^{-1}
X_{17}- Weight of individual fruit
X_{18}- Vitamin C
X_{19}- Crude protein
X_{20}- Total soluble solids
X_{21}- Fruit yield vine^{-1}

Table 2. Genotypic correlation coefficient in ridge gourd hybrids

	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}	X_{17}	X_{18}	X_{19}	X_{20}	X_{21}
X_1	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_2		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_3			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_4				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_5					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_6						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_7							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_8								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_9									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_{10}										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_{11}											1.000	0.595**	0.553*	0.073	0.616**	0.658**	0.880**	0.091	-0.007	0.232	0.870**
X_{12}												1.000	0.657**	0.408	0.583*	0.425	0.894**	0.204	-0.008	0.170	0.681**
X_{13}													1.000	0.345	0.587*	0.565*	0.590*	-0.414	0.134	0.366	0.611**
X_{14}														1.000	0.087	-0.045	0.152	0.069	0.280	0.172	-0.048
X_{15}															1.000	0.938**	0.667**	0.259	-0.167	-0.092	0.862**
X_{16}																1.000	0.625**	0.105	-0.178	0.229	0.909**
X_{17}																	1.000	0.152	-0.044	0.291	0.882**
X_{18}																		1.000	-0.154	0.005	0.103
X_{19}																			1.000	0.157	-0.137
X_{20}																				1.000	0.205
X_{21}																					1.000

* Significant at 5 per cent ** Significant at 1 per cent

X_1- Vine length at final harvest
X_2- Number of primary branches vine^{-1}
X_3- Days to first male flower anthesis
X_4- Days to first female flower anthesis
X_8- Number of female flowers vine^{-1}
X_9- Days to first harvest
X_{10}- Days to final harvest
X_{11}- Fruit length
X_{15}- Total number of harvest
X_{16}- Number of fruits vine^{-1}
X_{17}- Weight of individual fruit
X_{18}- Vitamin C

X_5- Days to 50 per cent flowering
X_6- Sex ratio
X_7- Number of male flowers vine^{-1}

X_{12}- Fruit girth
X_{13}- Number of seeds fruit^{-1}
X_{14}- 100 seed weight

X_{19}- Crude protein
X_{20}- Total soluble solids
X_{21}- Fruit yield vine^{-1}

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

	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}	X_{17}	X_{18}	X_{19}	X_{20}	$R_g(Y)$
X_1	**0.1475**	-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_2	0.0690	**-0.086**	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_3	-0.005	-0.002	**0.1559**	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_4	-0.018	0.008	0.0752	**0.5435**	-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_5	-0.057	0.0250	0.0371	0.5136	**-0.145**	-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_6	0.0247	0.016	-0.0382	-0.0599	0.0052	**0.2317**	-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_7	0.0859	-0.023	-0.0154	-0.1032	0.0399	0.1702	**-0.1482**	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_8	0.1099	-0.049	-0.0563	-0.2262	0.0756	-0.0046	-0.0619	**0.8451**	-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_9	0.0542	0.0136	0.0959	0.4843	-0.114	0.0099	-0.0419	-0.2689	**0.0093**	-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_{10}	0.1175	-0.037	0.0021	0.0481	-0.0032	-0.0065	-0.0384	0.5384	0.0037	**-0.6352**	-0.1141	-0.0337	0.0246	-0.0047	0.2001	-0.1258	0.7735	-0.0206	-0.0023	0.1074	**0.793****
X_{11}	0.0847	-0.052	-0.0097	0.0046	0.0232	-0.0399	-0.0334	0.6347	0.0019	-0.5392	**-0.1344**	-0.0316	0.0223	-0.0013	0.1909	-0.1142	0.8287	-0.0114	0.0001	0.0463	**0.870****
X_{12}	0.0318	-0.020	-0.0673	-0.0303	-0.014	-0.0559	0.0198	0.3775	-0.0005	-0.4033	-0.0800	**-0.0531**	0.0266	-0.0073	0.1808	-0.0737	0.8420	-0.0257	0.0001	0.0339	**0.681****
X_{13}	0.0621	-0.001	-0.0273	-0.1779	0.0326	-0.0419	-0.0024	0.4694	-0.0027	-0.3864	-0.0743	-0.0349	**0.0404**	-0.0062	0.1819	-0.0979	0.5551	0.0521	-0.0016	0.0729	**0.611****
X_{14}	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	**-0.0179**	0.0271	0.0078	0.1435	-0.0087	-0.0034	0.0343	**-0.048**
X_{15}	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	**0.3100**	-0.1627	0.6285	-0.0325	0.0020	-0.0183	**0.862****
X_{16}	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	**-0.1735**	0.5887	-0.0132	0.0022	0.0457	**0.909****
X_{17}	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	**0.9416**	-0.0191	0.0005	0.0580	**0.882****
X_{18}	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	**-0.1257**	0.0019	0.0009	**0.103**
X_{19}	-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	**-0.0122**	0.0312	**-0.137**
X_{20}	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	**0.1994**	**0.205**

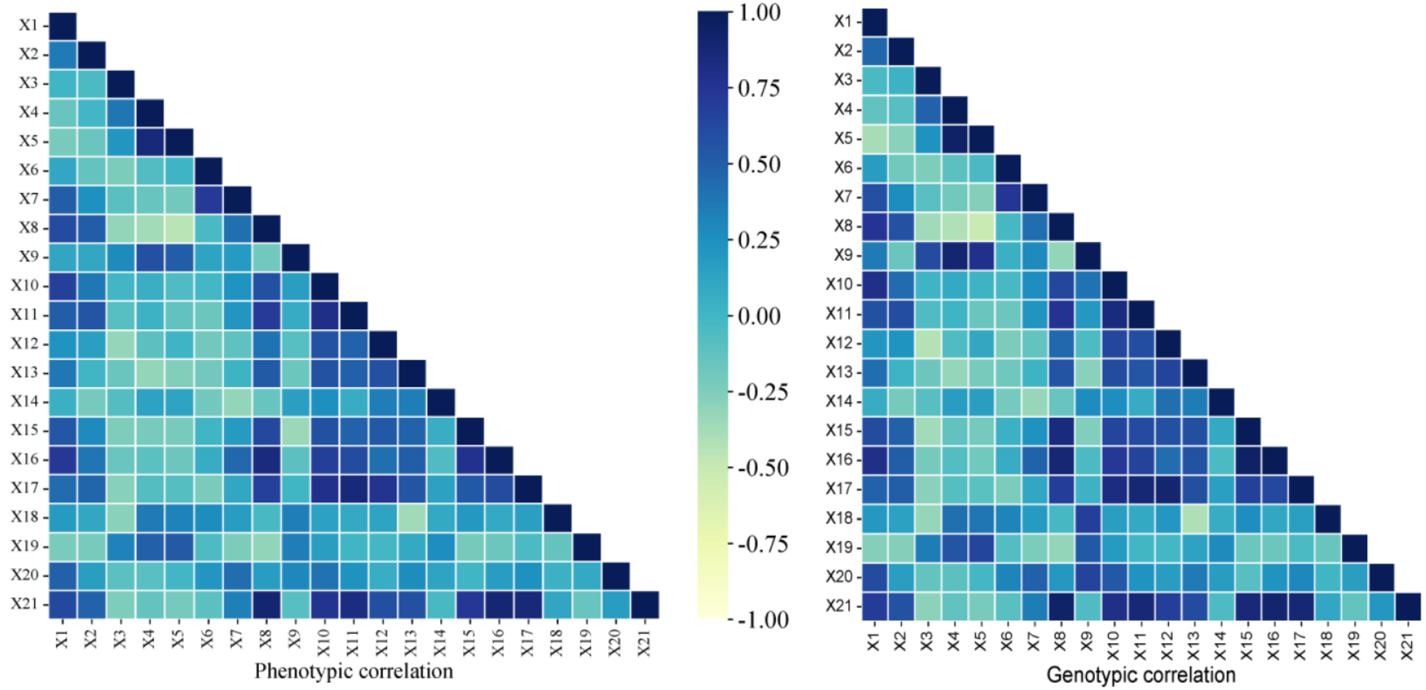
*Bold values indicate direct effect   Residual Effect = 0.1643931   Rg(Y)- Genotypic correlation coefficient with fruit yield vine^{-1}

X_1- Vine length at final harvest
X_2- Number of primary branches vine^{-1}
X_3- Days to first male flower anthesis
X_8- Number of female flowers vine^{-1}
X_9- Days to first harvest
X_{10}- Days to final harvest
X_{15}- Number of harvest
X_{16}- Number of fruits vine^{-1}
X_{17}- Weight of individual fruit

X_4- Days to first female flower anthesis
X_5- Days to 50 per cent flowering
X_6- Sex ratio
X_7- Number of male flowers vine^{-1}

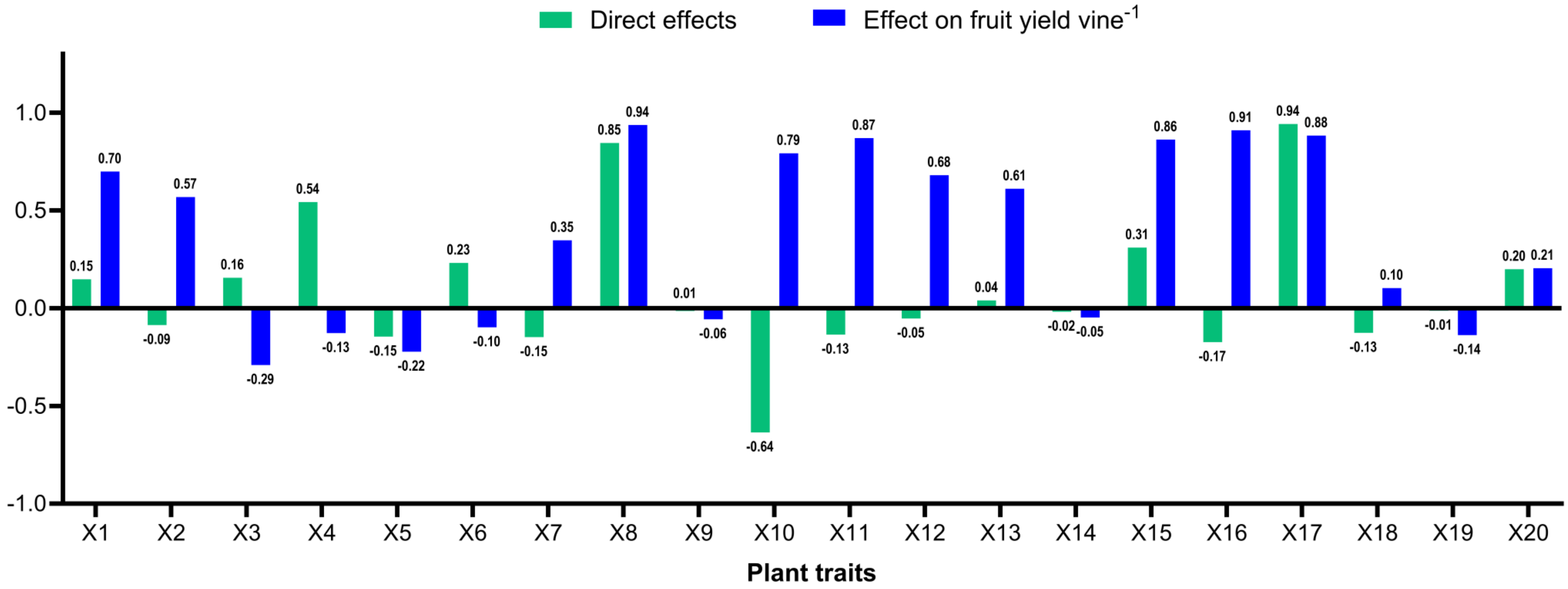
X_{11}- Fruit length
X_{12}- Fruit girth
X_{13}- Number of seeds fruit^{-1}
X_{14}- 100 seed weight

X_{18}- Vitamin C
X_{19}- Crude protein
X_{20}- Total soluble solids



X_1- Vine length at final harvest
X_2- Number of primary branches vine^{-1}
X_3- Days to first male flower anthesis
X_4- Days to first female flower anthesis
X_5- Days to 50 percent flowering
X_6- Sex ratio
X_7- Number of male flowers vine^{-1}
X_8- Number of female flowers vine^{-1}
X_9- Days to first harvest
X_{10}- Days to final harvest
X_{11}- Fruit length
X_{12}- Fruit girth
X_{13}- Number of seeds fruit^{-1}
X_{14}- 100 seed weight
X_{15}- Total number of harvest
X_{16}- Number of fruits vine^{-1}
X_{17}- Weight of individual fruit
X_{18}- Vitamin C
X_{19}- Crude protein
X_{20}- Total soluble solids

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

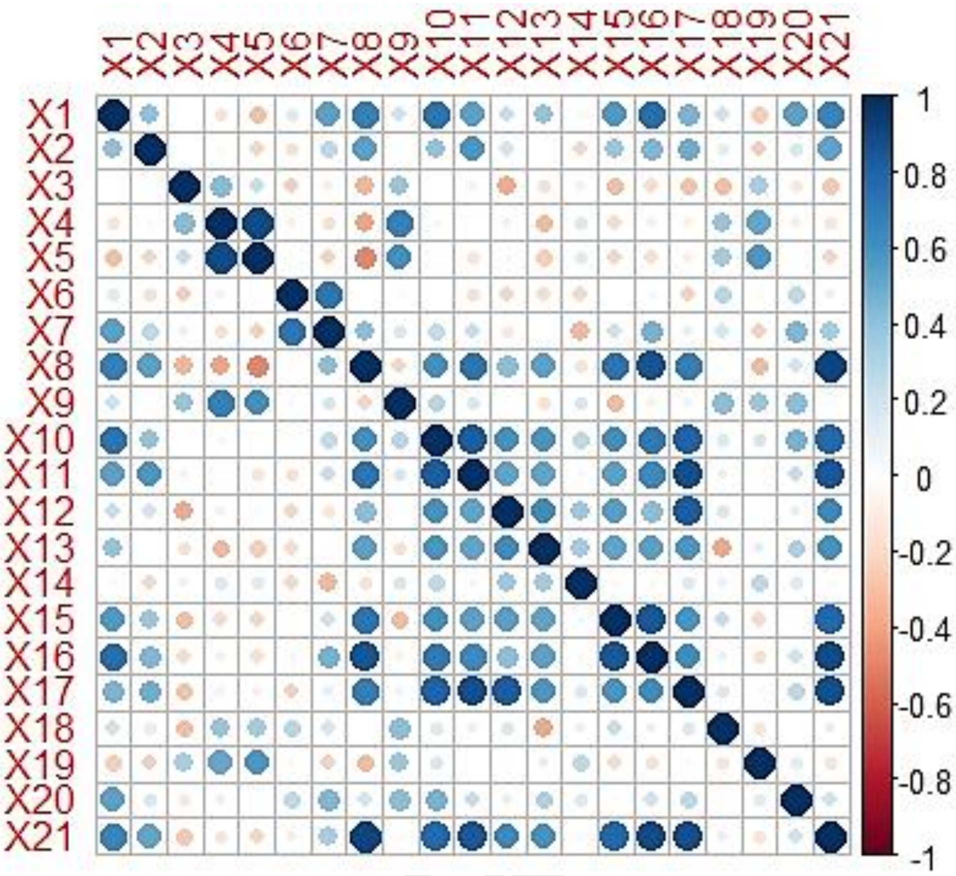


X_1- Vine length at final harvest
X_2- Number of primary branches vine^{-1}
X_3- Days to first male flower anthesis
X_4- Days to first female flower anthesis
X_5- Days to 50 per cent flowering
X_6- Sex ratio
X_7- Number of male flowers vine^{-1}

X_8 - Number of female flowers vine^{-1}
X_9 - Days to first harvest
X_{10}- Days to final harvest
X_{11}- Fruit length
X_{12}- Fruit girth
X_{13}- Number of seeds fruit^{-1}
X_{14}- 100 seed weight

X_{15}- Number of harvest
X_{16}- Number of fruits vine^{-1}
X_{17}- Weight of individual fruit
X_{18}- Vitamin C
X_{19}- Crude protein
X_{20}- Total soluble solids

Fig. 2. Direct effects of component traits and on fruit yield vine^{-1} of 18 ridge gourd hybrids



X_1- Vine length at final harvest
X_2- Number of primary branches vine^{-1}
X_3- Days to first male flower anthesis
X_4- Days to first female flower anthesis
X_5- Days to 50 percent flowering
X_6- Sex ratio
X_7- Number of male flowers vine^{-1}
X_8 - Number of female flowers vine^{-1}
X_9 - Days to first harvest
X_{10}- Days to final harvest
X_{11}- Fruit length
X_{12}- Fruit girth
X_{13}- Number of seeds fruit^{-1}
X_{14}- 100 seed weight
X_{15}- Total number of harvest
X_{16}- Number of fruits vine^{-1}
X_{17}- Weight of individual fruit
X_{18}- Vitamin C
X_{19}- Crude protein
X_{20}- Total soluble solids
X_{21}- Fruit yield vine^{-1}

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