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Character Association and Path coefficient Analysis for Yield and Yield Contributing Traits in F_2 Population of Bitter Gourd (*Momordica charantia* L.)

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ABSTRACT: The present investigation was carried out to determine correlation coefficient and path analysis in the F_2 population of HUB-1 × CO-1 of bitter gourd for 11 characters comprised of fruit yield and its contributing characters to identify transgressive segregants for further breeding programme. Yield is a dependent trait that is linked to a number of component traits. Selecting for yield directly may be less effective than selecting for traits that contribute to yield indirectly. The correlation coefficient is useful in determining the relative influence of the various characters on yield and helps to assess the probability of yield advancement by indirectly selecting its constituent characters, which are strongly correlated with yield. Path coefficient analysis proved useful in partitioning the correlation coefficient into direct and indirect effects and give an idea about the contribution of each independent character on dependent character *i.e.* yield. The 200 F2 population of HUB-1 × CO-1 constituted the experiment, which lied out in un-replicated at experimental Farm of the Department of Vegetable Science, Kittur Rani Chenamma College of Horticulture, Arabhavi, Belagavi District (Karnataka). The correlation coefficient suggested that there was a highly significant and positive association between fruit yield vine^{-1} and average fruit weight (0.821), fruit length (0.723), number of primary branches at final harvest (0.672), number of fruits vine^{-1} (0.659), number of seeds fruit^{-1} (0.639) and vine length at final harvest (0.620). The path analysis indicated that average fruit weight (0.72871) and number of fruits vine^{-1} (0.52488) had highest positive direct effects on fruit yield vine^{-1}. Based on the overall findings of the current study, it was concluded that the main attention should be placed on average fruit weight followed by number of fruit vine, number of primary branches at final harvest and fruit length, while exercising selection to improve yield.

Keywords: Bitter gourd, correlation, fruit yield, path analysis.

INTRODUCTION

The bitter gourd (*Momordica charantia* L.) is a member of the Cucurbitaceae family with somatic chromosomal number of 2n = 22 and is a diploid species. It is a broad genus that includes both annual and perennial climber species. It is called by different names around the world, but the most popular ones are african cucumber, bitter gourd, balsam pear, bitter melon and bitter cucumber. The bitter gourd most likely originated in eastern Asia, possibly in eastern India or southern China (Kole *et al.*, 2020). Fruits of the bitter gourd are used as stuffed, stir-fried, roasted and curried and can also be processed into pickled, canned and sliced dehydrated chips (Tindall, 1983). The fruit has laxative, antibilious, stomachic, and anthelmintic properties.

Additionally, it is a fruit tonic used to treat diabetes, gout, and rheumatism. A decoction of the root extract is beneficial in cases of abortion, haemorrhoids, and even biliousness (Khulakpam *et al.*, 2015). Yield is a quantifiable trait governed by multiple genes as well as the cumulative effect and strong impact of the environment on this. Yield is a dependent trait that is linked to a number of component traits. Selecting for yield directly may be less effective than selecting for traits that contribute to yield indirectly. Therefore, plant breeders commonly use indirect selection for complex traits. The study of correlation links between yield and yield-assigning traits is useful for identifying elite types among segregating populations. Path analysis extends the utility of information received from correlation studies by further splitting the coefficient of correlation into indirect and direct impacts. It illustrates the impact of each independent character on the dependent character, *i.e.* yield. Hence, the present study was conducted to determine the association of different characters with yield, direct and indirect influence of characters towards yield and yield contributing traits in F_2 segregating population to find preferable combinations as selection criteria for proliferating genotypes that can generate higher yields of bitter gourd.

MATERIAL AND METHODS

The present investigation was conducted with 200 F_2 population (HUB-1 × CO-1) of bitter gourd along with their parents HUB-1(gynoceious inbred line) and CO-1(Selection, monoceious inbred released from TNAU) between February 2022 to June 2022 at Experimental Farm of the Department of Vegetable Science, Kittur Rani Chenamma College of Horticulture (K.R.C.C.H.), Arabhavi, Belagavi District (Karnataka). K.R.C.C.H Arabhavi, is located in northern dry zone of Karnataka at 16º15´ North latitude, 74º45´ East longitude and at an altitude of 612.03 meter above mean sea level. Arabhavi, is in Zone-III of Region-II of Karnataka agroclimatic zones. This zone- III has benefits both from the South-West and North-East monsoons. The average precipitation in this location is roughly 74 mm spread over five months (February 2022 to June 2022), with a surge in May. From mid-July to mid-March, the administrative region receives water from the Ghataprabha Left Bank Stream. The experimental design followed for data analysis was un-replicated data analysis and the crop was raised with a spacing of 1.50 m × 1.00 m. To achieve good tilth, the ground was properly ploughed to a depth of 30 cm. Then, 20 t/ha of well-decomposed farmyard manure was applied and thoroughly mixed after all weeds, stones and stubbles had been removed. The site's gradient was taken into account when laying out the main and sub irrigation channels. The cultural operations and plant protection methods were carried out in accordance with the package of procedures provided by UHS, Bagalkot for bitter gourd. Observation were recorded on vine length at final harvest (m), number of primary branches at final harvest, days taken to appear 1st pistillate flowers, node at which 1st pistillate flower appeared, sex ratio (M/F), fruit length (cm), fruit diameter (cm), average fruit weight (g), number of fruits vine^{-1}, number of seeds fruit^{-1}, fruit yield vine^{-1} (kg). The correlation coefficient was performed to examine the relationship of characteristics with yield and also among yield attributes. The correlation coefficients were determined using the method of Al-Jibouri *et al*. (1958). Path coefficient analysis was performed utilising the phenotypic correlation values of yield components on yield as proposed by Dewey and Lu (1959). Statistical software packages named INDOSTAT were used to obtain the standard path coefficient, which was a standardised partial regression coefficient.

RESULT AND DISCUSSION

It is important to understand the dependencies between variables that have direct and indirect impacts on yield because yield is the outcome of multiplicative interactions between numerous yield components. The correlation coefficient demonstrates the relationship between two characters and serves as a foundation for selecting a preferred plant type. It helps to assess the probability of yield advancement by indirectly selecting its constituent characters, which are strongly correlated with yield. In the current study, the interrelationships between eleven traits were determined through their correlations. (Table 1 and Fig. 1). The correlation coefficient signalized that fruit yield vine^{-1} documented positive and highly significant correlation (at p=0.01) with average fruit weight (0.821), fruit length (0.723), number of primary branches at final harvest (0.672), number of fruits vine^{-1} (0.659), number of seeds fruit^{-1} (0.639), vine length at final harvest (0.620) and fruit diameter (0.359). Hence, these could be used as traits of concern for indirect selection to advance fruit yield per plant in the further breeding programme. The positive and significant association of fruit yield vine^{-1} with vine length at final harvest, number of primary branches at final harvest, number of fruits vine^{-1} and average fruit weight were in confirmation with the findings of Rani *et al.* (2014), Yadagiri *et al.* (2017); Dhathri *et al.* (2022) for the positive and significant association between fruit length, fruit diameter and number of seeds fruit^{-1} with fruit yield vine^{-1}. While, sex ratio (-0.301) showed a negative and significant correlation with fruit yield vine^{-1}. This indicates that, sex ratio had direct influence on number of fruits plant^{-1} hence, selection can be done with low sex ratio due to which number of fruits plant^{-1} can be increases and direct improvement of yield can be achieved. These findings were consistent with the results of Rani *et al.* (2014); Chinthan *et al*. (2021). Further node at which 1st

pistillate flower appeared (-0.340) and days taken to appear 1st pistillate flowers (-0.238) exhibited negative and significant association with fruit yield plant^{-1}. This showed that early flowering and lower node genotypes have reasonable association with the yield per plant. Hence, selection can be done with early flowering genotypes to improve the yield. These results were corroborated with the findings of Jatav *et al*. (2016); Kumari *et al*. (2018) in bitter gourd.

A precise picture of the proportional relevance of the indirect and direct impact of each component character on the desired character cannot be obtained from the simple connection data. However, path coefficient analysis will provide this information because it ahead splits the correlation coefficient into measures of direct and indirect impacts, helping us to perceive each character's direct or indirect contribution to the yield. Estimates of phenotypic path coefficient analysis for 10 characters in F_2 population of the cross HUB-1 × CO-1 are mentioned in Table 2 and also in Fig. 2. The path analysis indicated that average fruit weight (0.72871) unveiled highest positive direct effect on fruit yield vine^{-1} followed by number of fruits vine^{-1} (0.52488). The findings of Behera (2013); Tyagi *et al*. (2018); Triveni *et al*. (2021); Dhathri *et al*. (2022) in bitter gourd were agreement with above results. Furthermore the low positive direct effects of other traits on fruit yield vine^{-1} observed through fruit diameter (0.02719), number of primary branches at final harvest (0.02252), fruit length (0.02170) and sex ratio (0.0115). Similar results were reported by Rani *et al*. (2014); Khan *et al.* (2015); Dhathri *et al*. (2022). Thus, the greater extent of the positive direct effect of these characters elucidates the higher value of association among these traits and fruit yield per plant. So, the genotypes exhibited better performance for these traits would recompense for enhancement of yield in bitter gourd. Negative indirect effects on yield observed negligibly via node at which 1st pistillate flower appeared (-0.03917), vine length at final harvest (-0.01484), days taken to appear 1st pistillate flowers (-0.00515) and number of seeds fruit^{-1} (-0.00270). The results were in harmony with the discoveries of Khan *et al.* (2015); Jatav *et al.* (2016).

Table 1: Estimates of correlation coefficients of F_2 population "HUB-1 × CO-1" in bitter gourd.

	PH	NPB	NAFF	DTAFF	SR	FL	FD	FW	NFV	NSF	YPV
PH	**1**	0.482**	-0.003	-0.028	-0.024	0.511**	0.102	0.521**	0.439**	0.397**	0.620**
NPB		**1**	-0.537**	-0.555**	-0.556**	0.234**	0.159*	0.269**	0.825**	0.174*	0.672**
NAFF			**1**	0.847**	0.877**	0.131	0.002	0.132	-0.563**	0.092	-0.238**
DTAFF				**1**	0.829**	0.058	-0.073	0.057	-0.637**	0.074	-0.340**
SR		-			**1**	0.118	-0.136	0.067	-0.590**	0.058	-0.301**
FL						**1**	-0.053	0.873**	0.138	0.821**	0.723**
FD							**1**	0.384**	0.096	0.187**	0.359**
FW								**1**	0.131	0.836**	0.821**
NFV									**1**	0.027	0.659**
NSF										**1**	0.639**
YPV											**1**

* Significant at P = 0.05 **Significant at P = 0.01 Critical r value 0.1387 (5%) and 0.1817 (1%)

PH - Vine length at final harvest (m), NPB - Number of primary branches at final harvest, NAFF - Node at which 1st pistillate flower appeared, DTAFF - Days taken to appear 1st pistillate flowers, SR - Sex ratio (male: female), FL - Fruit length (cm), FD - Fruit diameter (cm), FW - Average fruit weight (g), NFV - Number of fruits vine^{-1}, NSF - Number of seeds fruit^{-1}, YPV - Fruit yield vine^{-1} (kg)

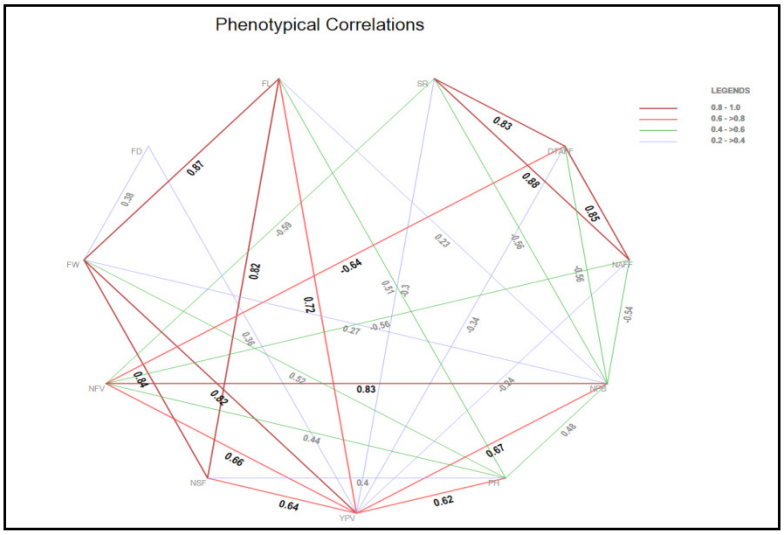

Fig. 1. Pictorial representation of phenotypic correlation coefficients of F_2 population "HUB-1 × CO-1" in bitter. Gourd.

Table 2: Estimates of direct and indirect effects of characters on fruit yield per plant in F_2 population of "HUB-1 × CO-1" in bitter gourd.

	PH	NPB	NAFF	DTAFF	SR	FL	FD	FW	NFV	NSF	YPV
PH	**-0.01484**	0.01085	0.00002	0.00111	-0.00026	0.01109	0.00276	0.3797	0.23028	-0.00107	0.6196
NPB	-0.00715	**0.02252**	0.00277	0.02175	-0.00619	0.00507	0.00433	0.19586	0.43303	-0.00047	0.6715
NAFF	0.00005	-0.01209	**-0.00515**	-0.03318	0.00977	0.00285	0.00005	0.09601	-0.29557	-0.00025	-0.2375
DTAFF	0.00042	-0.01251	-0.00436	**-0.03917**	0.00924	0.00125	-0.00198	0.04149	-0.33436	-0.0002	-0.3402
SR	0.00035	-0.01252	-0.00452	-0.03249	**0.01115**	0.00256	-0.00371	0.04876	-0.30994	-0.00016	-0.3005
FL	-0.00759	0.00527	-0.00068	-0.00226	0.00131	**0.0217**	-0.00143	0.6359	0.07254	-0.00222	0.7225
FD	-0.00151	0.00359	-0.00001	0.00286	-0.00152	-0.00114	**0.02719**	0.28	0.05044	-0.0005	0.3594
FW	-0.00773	0.00605	-0.00068	-0.00223	0.00075	0.01893	0.01045	**0.72871**	0.06861	-0.00225	0.8206
NFV	-0.00651	0.01858	0.0029	0.02495	-0.00658	0.003	0.00261	0.09525	**0.52488**	-0.00007	0.659
NSF	-0.0059	0.00392	-0.00048	-0.00292	0.00064	0.01782	0.00509	0.6093	0.01428	**-0.0027**	0.6391

Residual effect = 0.124

PH - Vine length at final harvest (m), NPB - Number of primary branches at final harvest, NAFF - Node at which 1st pistillate flower appeared, DTAFF - Days taken to appear 1st pistillate flowers, SR - Sex ratio (male: female), FL - Fruit length (cm), FD - Fruit diameter (cm), FW - Average fruit weight (g), NFV - Number of fruits vine^{-1}, NSF - Number of seeds fruit^{-1}, YPV - Fruit yield vine^{-1} (kg)

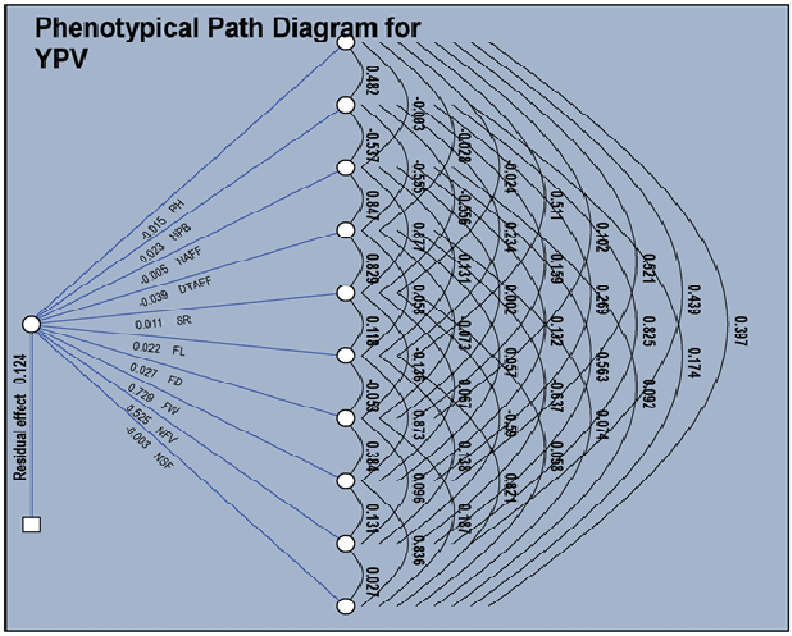

Fig. 2. Pictorial representation of phenotypic path diagram for fruit yield per plant (kg) in F_2 segregating population of the cross HUB-1 × CO-1.

CONCLUSION

Correlation and path analysis demonstrated that advancement in yield may be possible by adopting traits such as average fruit weight, number of fruits per plant, number of primary branches at final harvest, fruit length and fruit diameter as selection criteria for crop improvement in bitter gourd.

FUTURE SCOPE

Based on the above results, the conclusion drawn is that in general all the characters studied among this population (HUB^{-1} × CO^{-1}) emerged as potential population for improving productivity as had high association with fruit yield. Hence, this population can be advanced further through selection to develop a potential genotype.

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Conflict of Interest. None.

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