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Character association for yield and its contributing traits in Bitter gourd (*Momordica charantia* L.)

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Abstract
A field experiment was conducted during March to July, 2022 to determine correlation coefficient and path analysis among 28 genotypes for 18 characters comprised of fruit yield and its contributing characters. These genotypes were planted in Randomized Block Design with three replications at Vegetable Research Centre, G. B. Pant University of Agriculture & Technology, Pantnagar. The result revealed that at genotypic and phenotypic level maximum significant and positive correlation was shown by fruit weight (cm), fruit length (cm), fruit diameter (cm), total number of pickings and number of seeds per fruit. The results of path coefficient analysis indicated that at phenotypic and genotypic level, the effect was significant and positive direct effect on fruit yield per plant (kg) was contributed by the character fruit weight (g) followed by number of fruits per plant, days to first male flower, number of pickings, fruit diameter (cm), days to first fruit harvest, main vine length (m), number of seeds per fruit, sex ratio, days to first female flower, node number at which first female flower appears and number of nodes per vine. Hence, these characters may be simultaneously selected for developing better quality high yielding varieties of bitter gourd.

Keywords: Bitter gourd, correlation, fruit yield, path analysis, phenotypic and genotypic

1. Introduction
Bitter gourd (*Momordica charantia* L., 2n=2x=22) commonly known as bitter melon, bitter apple, bitter cucumber, bitter squash, balsam-pear is a tropical and subtropical vine of the family Cucurbitaceae (Ram, 2005) [19], widely grown in Asia and Africa for its edible fruit. *Momordica* is a large genus having about 60 species of both annual and perennial climbers of which *Momordica charantia* L., is widely cultivated. The wild species *M. charanatia* var. *abbreviate* Ser. of Asia may be the progenitor of cultivated bitter gourd. Bitter gourd fruits are a good source of carbohydrates, proteins, vitamins and minerals and have the highest nutritive value among cucurbits (Desai and Musmade, 1998) [1]. The fruit also contains two alkaloids namely momordicine and cucurbitacin having bitter principle and characin which have antidiabetic properties. Correlation, in general, measures the extent and direction (positive or negative) of a relationship occurring between two or more characteristics (Gomez and Gomez, 1984) [4]. The estimate of genetic correlation (rg) refers to the association between two plant characters due to the genetic constitution of the plant, whereas phenotypic correlation (rp) refers to the correlation between two plant characters due to their physical appearance at a morphological, anatomical, or biochemical level (Zhang *et al*., 2005) [18]. Path co-efficient Analysis is simply a standardized partial regression analysis and as such measures the direct influence of one variable upon the other and permits separation of correlation into direct and indirect effects. Path analysis has been used extensively in agronomic and environmental studies (Zhang *et al*., 2005) [18]. Path co-efficient Analysis developed by Wright (1921) [17] turns out helpful in segregating the correlation coefficient into direct and indirect effect. It gives a gist about the contribution of each independent character on dependent character like yield.

2. Materials and Methods
The present investigation was carried out at Vegetable Research Centre, Govind Ballabh Pant University of Agriculture & Technology, Pantnagar, and Uttarakhand during March- July months of the year 2022. The experimental material for the present study 28 genotypes of bitter gourd consisted of landraces, varieties and genotypes collected from different State Agricultural Universities, ICAR Research Institutes, local land races form Uttarakhand, Chhattisgarh, Orissa and Andhra Pradesh. The experiment was laid out in Randomized Block

Design with three replications of each genotype. The row to row spacing of 2.0 m. and plant to plant spacing of 0.60 m. was maintained. Phenotypic and genotypic correlations will be worked out by using formula suggested by Falconer (1964) [20]. Path coefficient analysis was carried out as suggested by Dewey and Lu (1959) [2] by partitioning the simple correlation coefficients into direct and indirect effects. The direct and indirect effects were ranked based on the scales of Lenka and Misra (1973) [10] as given below:

3. Result and Discussion

3.1 Correlation coefficient

Phenotypic and genotypic correlation coefficients among eighteen quantitative characters are presented in Table 1. Fruit yield per plant exhibited highly significant and positive association with average fruit weight (0.770** P, 0.786**G), fruit length (0.374** P, 0.389** G), fruit diameter (0.596** P, 0.657** G), total number of pickings (0.562** P, 0.652** G) and number of seeds per fruit (0.480** P, 0.499** G). Similar findings are also reported by Pathak *et al*. (2014) [12] fruit length and fruit diameter, Tyagi *et al.* (2018) [16] for average fruit weight (g), Kumari *et al.*, (2019), Sowmya *et al.*, (2019), Rahman *et al.*, (2021) [9, 13, 14] for fruit weight and fruit length. Sundaram (2010) [15] observed significant and positive correlation between number of fruits per vine, fruit weight, fruit length and fruit diameter.

The phenotypic and genotypic correlation for main vine length (m) was significant and positively correlated with internodal length (0.568 P, 0.627 G), number of nodes per vine (0.578 P, 0.588 G), days to first male flower (0.241 P, 0.254 G), days to first female flower (0.379 P, 0.386 G), node number at which first male flower appears (0.251 P, 0.280 G), node number at which first female flower appears (0.347 P, 0.355 G), days to 50% flowering (0.375 P, 0.398 G) and days to first fruit harvest (0.492 P, 0.510 G) while negative significant correlation was noticed with number of fruits per plant (-0.341 P, -0.345 G) and total number of pickings (-0.311 P, 0.343 G). Number of primary branches per vine showed positive and highly significant correlation with sex ratio (0.383 P, 0.393 G) and number of fruits per plant (0.303 P, 0.306 G) whereas, negative and significant correlation was noticed with fruit diameter (-0.373 P. -0.398 G), fruit weight (-0.245 P, -0.250), number of seeds per fruit (-0.292 P, -0.305 G) and fruit yield per plant (-0.239 P, -0.250 G). Internodal length was significant, positively correlated with days to first male flower (0.240 P, 0.274 G), node number at which first male flower appears (0.256 P, 0.333 G) and days to first fruit harvest (0.262 P, 0.308 G).

The correlation of number of nodes per vine was positive and significantly correlated with node number at which first female flower appears (0.237 P, 0.256 G) and fruit length (0.317 P, 0.328 G) while negative and significant correlation was noticed with total number of pickings (-0.295 P, -0.318 G). Days to first male flower was positive and significantly correlated with days to first female flower (0.723 P, 0.741 G), node number at which first male flower appears (0.357 P, 0.395 G), days to 50% flowering (0.708 P, 0.738 G) and days to first fruit harvest (0.643 P, 0.670) whereas, negative and significant correlation was noticed with fruit diameter (-0.426 P, -0.457 G) and total number of pickings (-0.278 P, -0.299 G). Days to first female flower was positive and significantly correlated with node number at which first male flower appears (0.304 P, 0.335 G), node number at which first female flower appears (0.251 P, 0.270 G), days to 50% flowering (0.850 P, 0.890 G) and days to first fruit harvest (0.908 P, 0.925 G) while negative and significant correlation was noticed with fruit diameter (-0.438 P, -0.468), total number of pickings (-0.338 P, -0.365 G) and fruit yield per plant (-0.237 P, -0.241 G). Node number at which first male flower appears was positive and significantly correlated with node number at which first female flower appears (0.285 P, 0.364 G), days to 50% flowering (0.306 P, 0.341), days to first fruit harvest (0.358 P, 0.404 G) and fruit length (0.309 P, 0.344 G) while negative and significant correlation was noticed with number of fruits per plant (-0.436 P, -0.466 G). Node number at which first female flower appears was positive and significantly correlated with days to 50% flowering (0.242 P, 0.268 G), fruit length (0.303**) and number of seeds per fruit (0.253 P, 0.278 G).

Days to 50% flowering was positive and significantly correlated with sex ratio (0.902) phenotypically and with days to first fruit harvest (0.926) genotypically whereas, negative and significant correlation was noticed with fruit diameter (-0.418 P, -0.471 G), total number of pickings (-0.299 P, -0.359 G) and fruit yield per plant (-0.233 P, -0.238 G). Sex ratio was negatively and significantly correlated with average fruit length (-0.297 P, -0.311), average fruit diameter (-0.239P, -0.263 G), average fruit weight (-0.490 P, -0.499 G), number of seeds per fruit (-0.419 P, -0.427 G), total number of pickings (-0.231 P, -0.260) and fruit yield per plant (-0.444 P, -0.460 G). Days to first fruit harvest was negatively and significantly correlated with average fruit diameter (-0.408 P, -0.443 G), number of fruits per plant (-0.246 P, -0.252 G), total number of pickings (-0.368 P, -0.412 G) and fruit yield per plant (-0.231 P, -0.237 G).

Fruit length was positive and significantly correlated with fruit diameter (0.397 P, 0.432 G), fruit weight (0.756 P, 0.772 G), number of seeds per fruit (0.424 P, 0.439 G) and fruit yield per plant (0.375 P, 0.389 G) while negative and significant correlation was noticed with number of fruits per plant (-0.613 P, -0.621 G). Fruit diameter was positive and significantly correlated with fruit weight (0.636 P, 0.681 G), number of seeds per fruit (0.388 P, 0.430 G), total number of pickings (0.245 P, 0.272 G) and fruit yield per plant (0.596 P, 0.657) while negative and significant correlation was noticed with number of fruits per plant (-0.462 P, -0.500 G). Fruit weight was positive and significantly correlated with number of seeds per fruit (0.512 P, 0.530 G), total number of pickings (0.282 P, 0.313 G) and fruit yield per plant (0.770 P, 0.786 G) while negative and significant correlation was noticed with number of fruits per plant (-0.559 P, -0.564 G). Number of fruits per plant was positive and significantly correlated with total number of pickings (0.283 P, 0.312 G) while negative and significant correlation was noticed with number of seeds per fruit (-0.389 P, -0.399 G). Number of seeds per fruit was positive and significantly correlated with fruit yield per plant (0.480 P, 0.499 G). Total number of pickings was positive and significantly correlated with fruit yield per plant (0.562 P, 0.652 G).

Similar to these results Gupta *et al*. (2013), Tyagi *et al.* (2018), Kumari *et al.* (2021) [5, 16, 7] also observed high magnitude of genotypic correlation than the corresponding phenotypic correlation for most of the characters combinations establishing predominant role of heritable factor.

Table 1: Phenotypic (P) and Genotypic (G) correlation coefficients of yield and yield related attributes in 28 genotypes of Bitter gourd

		MVL	NPB	IL	NNPV	DFMF	DFFF	NNMF	NNFF	DFF	SR	DFFH	FL	FD	FW	NFPP	NSPF	TNP	FYPP
MVL	P	1.000																	
	G	1.000																	
NPB	P	0.098	1.000																
	G	0.100	1.000																
IL	P	0.568**	0.139	1.000															
	G	0.627**	0.151	1.000															
NNPV	P	0.578**	0.008	-0.190	1.000														
	G	0.588**	0.010	-0.214	1.000														
DFMF	P	0.241*	0.161	0.240*	-0.015	1.000													
	G	0.254*	0.166	0.274*	-0.015	1.000													
DFFF	P	0.379**	0.153	0.194	0.094	0.723**	1.000												
	G	0.386**	0.151	0.221*	0.099	0.741**	1.000												
NNMF	P	0.251*	0.097	0.256*	-0.045	0.357**	0.304**	1.000											
	G	0.280**	0.115	0.333**	-0.051	0.395**	0.335**	1.000											
NNFF	P	0.347**	0.068	0.114	0.237*	0.186	0.251*	0.285**	1.000										
	G	0.355**	0.079	0.133	0.256*	0.204	0.270*	0.364**	1.000										
DFF	P	0.375**	0.149	0.196	0.090	0.708**	0.850**	0.306**	0.242*	1.000									
	G	0.398**	0.151	0.227*	0.103	0.738**	0.890**	0.341**	0.268*	1.000									
SR	P	0.109	0.383**	-0.006	0.084	-0.184	-0.158	-0.101	-0.031	-0.161	1.000								
	G	0.111	0.393**	-0.002	0.086	-0.191	-0.164	-0.102	-0.051	-0.165	1.000								
DFFH	P	0.492**	0.188	0.262*	0.152	0.643**	0.908**	0.358**	0.143	0.902**	-0.084	1.000							
	G	0.510**	0.190	0.308**	0.155	0.670**	0.926**	0.404**	0.148	0.926**	-0.086	1.000							
FL	P	0.203	-0.064	-0.036	0.317**	-0.076	0.035	0.309**	0.303**	0.031	-0.297**	0.061	1.000						
	G	0.206	-0.067	-0.058	0.328**	-0.072	0.035	0.344**	0.328**	0.029	-0.311**	0.065	1.000						
FD	P	-0.108	-0.373**	0.028	-0.083	-0.426**	-0.438**	0.140	-0.052	-0.418**	-0.239*	-0.408**	0.397**	1.000					
	G	-0.105	-0.398**	0.049	-0.088	-0.457**	-0.468**	0.176	-0.014	-0.471**	-0.263*	-0.443**	0.432**	1.000					
FW	P	0.068	-0.245*	-0.064	0.129	-0.158	-0.025	0.195	0.095	-0.021	-0.490**	-0.000	0.756**	0.636**	1.000				
	G	0.071	-0.250*	-0.073	0.134	-0.167	-0.025	0.219*	0.098	-0.027	-0.499**	-0.002	0.772**	0.681**	1.000				
NFPP	P	-0.341**	0.303**	-0.168	-0.100	0.043	-0.136	-0.436**	-0.205	-0.140	0.024	-0.246*	-0.613**	-0.462**	-0.559**	1.000			
	G	-0.345**	0.306**	-0.186	-0.102	0.043	-0.137	-0.466**	-0.219*	-0.144	0.026	-0.252*	-0.621**	-0.500**	-0.564**	1.000			
NSPF	P	0.092	-0.292**	0.066	0.072	0.154	0.053	0.128	0.253*	0.059	-0.419**	-0.009	0.424**	0.388**	0.512**	-0.389**	1.000		
	G	0.094	-0.305**	0.051	0.077	0.167	0.050	0.169	0.278*	0.062	-0.427**	-0.007	0.439**	0.430**	0.530**	-0.399**	1.000		
TNP	P	-0.311**	0.033	-0.101	-0.295**	-0.278*	-0.338**	-0.201	-0.145	-0.299**	-0.231*	-0.368**	0.055	0.245*	0.282**	0.283**	0.093	1.000	
	G	-0.343**	0.065	-0.125	-0.318**	-0.299**	-0.365**	-0.262*	-0.175	-0.359**	-0.260*	-0.412**	0.065	0.272*	0.313**	0.312**	0.132	1.000	
FYPP	P	-0.047	-0.239*	-0.054	0.030	-0.160	-0.237*	-0.084	-0.050	-0.233*	-0.444**	-0.231*	0.374**	0.596**	0.770**	-0.137	0.480**	0.562**	1.000
	G	-0.048	-0.250*	-0.058	0.028	-0.176	-0.241*	-0.086	-0.063	-0.238*	-0.460**	-0.237*	0.389**	0.657**	0.786**	-0.140	0.499**	0.652**	1.000

* Significant at 5%, ** Significant at 1%MVL- main vine length(m), NPB- number of primary branches per vine, IL-internodal length, NNPV- number of nodes per vine, DFMF-days to first male flower, DFFF- days to first female flower, NNMF-node number at which first male flower appears, NNFF-node number at which first female flower appears, DFF- days to 50% flowering, SR-sex ratio, DFFH-days to first fruit harvest, FL- fruit length (cm), FD- fruit diameter (cm), FW- fruit weight (g), NFPP- number of fruits per plant, NSPF- number of seeds per fruit, TNP- Total number of pickings, FYPP-fruit yield per plant (kg).

Table 2: Phenotypic (P) and Genotypic (G) path coefficient analysis on fruit yield per plant in twenty-eight genotypes of Bitter gourd

		MVL	NPB	IL	NNPV	DFMF	DFFF	NNMF	NNFF	DFF	SR	DFFH	FL	FD	FW	NFPP	NSPF	TNP
MVL	P	0.141	0.014	0.080	0.081	0.034	0.053	0.035	0.049	0.053	0.015	0.069	0.029	-0.015	0.010	-0.048	0.013	-0.044
	G	0.134	0.013	0.084	0.079	0.034	0.052	0.038	0.048	0.053	0.015	0.068	0.028	-0.014	0.010	-0.046	0.013	-0.046
NPB	P	-0.008	-0.081	-0.011	-0.001	-0.013	-0.012	-0.008	-0.006	-0.012	-0.031	-0.015	0.005	0.030	0.020	-0.025	0.024	-0.003
	G	-0.010	-0.104	-0.016	-0.001	-0.017	-0.016	-0.012	-0.008	-0.016	-0.041	-0.020	0.007	0.041	0.026	-0.032	0.032	-0.007
IL	P	-0.010	-0.002	-0.017	0.003	-0.004	-0.003	-0.004	-0.002	-0.003	0.000	-0.004	0.001	-0.001	0.001	0.003	-0.001	0.002
	G	-0.034	-0.008	-0.054	0.012	-0.015	-0.012	-0.018	-0.007	-0.012	0.000	-0.017	0.003	-0.003	0.004	0.010	-0.003	0.007
NNPV	P	0.003	0.000	-0.001	0.004	0.000	0.000	0.000	0.001	0.000	0.000	0.001	0.001	0.000	0.001	0.000	0.000	-0.001
	G	0.020	0.000	-0.007	0.035	-0.001	0.003	-0.002	0.009	0.004	0.003	0.005	0.011	-0.003	0.005	-0.004	0.003	-0.011
DFMF	P	0.064	0.043	0.064	-0.004	0.266	0.192	0.095	0.050	0.188	-0.049	0.171	-0.020	-0.113	-0.042	0.012	0.041	-0.074
	G	0.091	0.060	0.098	-0.005	0.358	0.265	0.141	0.073	0.264	-0.068	0.240	-0.026	-0.164	-0.060	0.015	0.060	-0.107
DFFF	P	0.018	0.007	0.009	0.004	0.033	0.046	0.014	0.012	0.045	-0.007	0.042	0.002	-0.020	-0.001	-0.006	0.002	-0.016
	G	0.167	0.065	0.095	0.043	0.320	0.432	0.145	0.116	0.433	-0.071	0.400	0.015	-0.202	-0.011	-0.059	0.022	-0.158
NNMF	P	-0.029	-0.011	-0.030	0.005	-0.041	-0.035	-0.115	-0.033	-0.035	0.012	-0.041	-0.036	-0.016	-0.022	0.050	-0.015	0.023
	G	-0.055	-0.022	-0.065	0.010	-0.077	-0.065	-0.195	-0.071	-0.067	0.020	-0.079	-0.067	-0.034	-0.043	0.091	-0.033	0.051
NNFF	P	0.006	0.001	0.002	0.004	0.003	0.004	0.005	0.016	0.004	-0.001	0.002	0.005	-0.001	0.002	-0.003	0.004	-0.002
	G	0.026	0.006	0.010	0.019	0.015	0.020	0.027	0.075	0.020	-0.004	0.011	0.024	-0.001	0.007	-0.016	0.021	-0.013
DFF	P	-0.142	-0.056	-0.074	-0.034	-0.267	-0.371	-0.116	-0.091	-0.378	0.061	-0.340	-0.012	0.158	0.008	0.053	-0.022	0.113
	G	-0.347	-0.132	-0.198	-0.090	-0.644	-0.876	-0.298	-0.234	-0.872	0.144	-0.808	-0.026	0.411	0.024	0.126	-0.055	0.313
SR	P	0.012	0.042	-0.001	0.009	-0.020	-0.018	-0.011	-0.003	-0.018	0.110	-0.009	-0.033	-0.026	-0.054	0.003	-0.046	-0.026
	G	0.015	0.052	0.000	0.011	-0.025	-0.022	-0.013	-0.007	-0.022	0.132	-0.011	-0.041	-0.035	-0.066	0.003	-0.057	-0.034
DFFH	P	0.076	0.029	0.040	0.023	0.099	0.139	0.055	0.022	0.138	-0.013	0.154	0.009	-0.063	0.000	-0.038	-0.001	-0.056
	G	0.198	0.074	0.119	0.060	0.260	0.359	0.157	0.057	0.359	-0.033	0.387	0.025	-0.172	-0.001	-0.098	-0.003	-0.160
FL	P	-0.053	0.017	0.009	-0.082	0.020	-0.009	-0.080	-0.078	-0.008	0.077	-0.016	-0.259	-0.103	-0.196	0.159	-0.110	-0.014
	G	-0.051	0.017	0.014	-0.081	0.018	-0.009	-0.085	-0.081	-0.007	0.077	-0.016	-0.248	-0.107	-0.191	0.154	-0.109	-0.016

FD	P	-0.020	-0.070	0.005	-0.016	-0.080	-0.083	0.026	-0.010	-0.079	-0.045	-0.077	0.075	0.188	0.120	-0.087	0.073	0.046
	G	-0.041	-0.155	0.019	-0.034	-0.178	-0.182	0.068	-0.005	-0.183	-0.102	-0.172	0.168	0.389	0.265	-0.194	0.167	0.106
FW	P	0.066	-0.238	-0.062	0.126	-0.153	-0.025	0.189	0.093	-0.020	-0.475	0.000	0.734	0.617	0.971	-0.542	0.497	0.274
	G	0.059	-0.207	-0.060	0.111	-0.138	-0.021	0.182	0.082	-0.022	-0.414	-0.002	0.641	0.566	0.830	-0.469	0.440	0.260
NFPP	P	-0.107	0.095	-0.053	-0.031	0.014	-0.043	-0.136	-0.064	-0.044	0.007	-0.077	-0.191	-0.144	-0.174	0.312	-0.121	0.088
	G	-0.101	0.089	-0.054	-0.030	0.013	-0.040	-0.136	-0.064	-0.042	0.008	-0.073	-0.181	-0.146	-0.164	0.291	-0.116	0.091
NSPF	P	0.011	-0.035	0.008	0.009	0.018	0.006	0.015	0.030	0.007	-0.050	-0.001	0.050	0.046	0.061	-0.046	0.119	0.011
	G	0.007	-0.021	0.004	0.005	0.012	0.003	0.012	0.019	0.004	-0.030	-0.001	0.030	0.030	0.037	-0.028	0.069	0.009
TNP	P	-0.075	0.008	-0.024	-0.071	-0.067	-0.082	-0.049	-0.035	-0.072	-0.056	-0.089	0.013	0.059	0.068	0.068	0.022	0.241
	G	-0.126	0.024	-0.046	-0.117	-0.110	-0.134	-0.096	-0.064	-0.132	-0.095	-0.152	0.024	0.100	0.115	0.115	0.049	0.367
FYPP	P	-0.047	-0.239	-0.054	0.030	-0.160	-0.237	-0.084	-0.050	-0.233	-0.444	-0.231	0.374	0.596	0.770	-0.137	0.480	0.562
	G	-0.048	-0.250	-0.058	0.028	-0.176	-0.241	-0.086	-0.063	-0.238	-0.460	-0.238	0.389	0.657	0.786	-0.140	0.499	0.652
Partial R^2	P	-0.007	0.019	0.001	0.000	-0.043	-0.011	0.010	-0.001	0.088	-0.049	-0.036	-0.097	0.112	0.748	-0.043	0.057	0.135
	G	-0.006	0.026	0.003	0.001	-0.063	-0.104	0.017	-0.005	0.207	-0.061	-0.092	-0.096	0.255	0.653	-0.041	0.035	0.239

P- R Square = 0.8853 Residual Effect = 0.3387 G- R SQUARE = 0.9679 Residual Effect = 0.1791

MVL- main vine length(m), NPB- number of primary branches per vine, IL-internodal length, NNPV-number of nodes per vine, DFMF-days to first male flower, DFFF- days to first female flower, NNMF-node number at which first male flower appears, NNFF-node number at which first female flower appears, DFF- days to 50% flowering, SR-sex ratio, DFFH-days to first fruit harvest, FL- fruit length (cm), FD- fruit diameter (cm), FW- fruit weight (g), NFPP- number of fruits per plant, NSPF- number of seeds per fruit, TNP-Total number of pickings, FYPP-fruit yield per plant(kg)

3.2 Path analysis

The results of path coefficient analysis were indicated in table 2. The phenotypic and genotypic path coefficient analysis reported that positive direct effect on fruit yield per plant was contributed by the character fruit weight (0.971 P, 0.830 G), number of fruits per plant (0.312 P, 0.291 G), days to first male flower(0.266 P, 0.358 G), total number of pickings (0.241 P, 0.367 G), fruit diameter (0.188 P, 0.389 G), days to first fruit harvest (0.154 P, 0.387 G), main vine length(0.141 P, 0.134 G), number of seeds per fruit (0.119 P, 0.069 G), sex ratio(0.110 P, 0.132 G), days to first female flower(0.046 P, 0.075 G) whereas, negative direct effect was by internodal length (-0.017 P, -0.054 G), number of primary branches per vine (-0.081 P, -0.104 G), node number at which first male flower appears (-0.115 P, -0.195 G), fruit length (-0.259 P, -0.248 G) and days to 50% flowering (-0.378 P, -0.872 G).

Maximum direct effect shown by fruit weight at phenotypic and genotypic level because, it was most important character as it was having maximum direct effect on fruit yield per plant. Similarly, positive association with yield with number of female flowers per vine, number of fruits per vine, vine length and fruit weight by Sundaram (2010) [15], number of fruits per vine and average fruit weight by Mahesh *et al*. (2014) [11], marketable fruits per vine, average fruit weight, seeds per fruit, number of days to first female flower appearance, branches per plant and node at which first female flower appears by Gupta *et al*. (2015) [6], number of fruits per plant and average fruit weight (g) by Kumari *et al.* (2018) [9]. Dubey and Pandey (2019) [3] reported the direct positive effect of number of fruits per followed by vine length on fruit yield per plant. Similarly, direct positive effect on fruit yield per plant with fruit length, fruit weight and number of fruits per plant by Rahman *et al.* (2021) [13].

4. Conclusion

Genetic parameters associated with a correlation study indicated that primary emphasis should be given to fruit weight (g) followed by fruit length (cm), fruit diameter (cm), number of pickings and number of seeds per fruit for the selection of superior genotypes. Path coefficient analysis further suggested that highest direct effects on the fruit yield per plant (kg) was contributed by the character fruit weight (g) followed by number of fruits per plant, days to first male flower, number of pickings, average fruit diameter (cm) and days to first fruit harvest.

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