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CORRELATION AND PATH COEFFICIENT STUDIES IN BOTTLE GOURD

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ABSTRACT

The present investigation was conducted during Kharif 2025 at the Crop Research Centre, Department of Horticulture, School of Agriculture, ITM University, Gwalior (M.P.) India, to study character association and path coefficient analysis in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]. Nineteen genotypes including one check variety were evaluated in a Randomized Block Design with three replications. Observations were recorded on fourteen quantitative and quality traits. Correlation analysis revealed that fruit yield per plant exhibited significant positive association with average fruit weight, fruit circumference, number of fruits per plant and number of primary branches per plant, whereas negative association was observed with days to first staminate flower anthesis, days to first pistillate flower anthesis and days to first fruit harvest. Path coefficient analysis indicated that number of fruits per plant exerted the highest positive direct effect on fruit yield per plant followed by average fruit weight. The results suggested that these traits are major yield determinants and should be considered as important selection criteria in bottle gourd improvement programmes.
Keywords **:** Bottle gourd, correlation coefficient, path analysis, fruit yield.

Introduction

Bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] is one of the most ancient cultivated vegetable crops belonging to the family Cucurbitaceae. It is extensively cultivated in tropical and subtropical regions due to its adaptability, nutritional value and high economic returns. The crop possesses considerable variability for fruit shape, size, yield and quality attributes, which provides ample scope for genetic improvement. In India, the total area covered under bottle gourd is 0.223 million ha. with production of 3.72 million tonnes and its productivity is 16.68 tonnes per ha. (Anonymous, 2025-26).

Fruit yield is a complex quantitative trait governed by several component characters and their interactions. Therefore, direct selection based solely on yield is often ineffective. Correlation analysis provides information regarding the degree and direction of association among traits, whereas path coefficient analysis partitions the correlation coefficient into direct and indirect effects, thereby helping breeders identify the most important yield-contributing traits. Knowledge of character association and path coefficients is essential for designing effective selection strategies in crop improvement programmes. Keeping these facts in view, the present investigation was undertaken to study the correlation and path coefficient analysis among yield and yield contributing traits in bottle gourd.

Materials and Methods

The experimental material consisted of nineteen bottle gourd genotypes including the check variety Narendra Rashmi. The experiment was conducted during Kharif 2025 at the Crop Research Centre, Department of Horticulture, School of Agriculture, ITM University, Gwalior (M.P.) India. The genotypes were evaluated in a Randomized Block Design with three replications.

Observations were recorded on fourteen characters, namely days to first staminate flower anthesis, days to first pistillate flower anthesis, node number to first staminate flower, node number to first pistillate flower, days to first fruit harvest, vine length (m), number of primary branches per plant, fruit length

(cm), fruit circumference (cm), average fruit weight (kg), number of fruits per plant, fruit yield per plant (kg), total soluble solids (°Brix) and ascorbic acid (mg/100 g fresh fruit).

Phenotypic and genotypic correlation coefficients were estimated according to the method suggested by Al-Jibouri *et al*. (1958). Path coefficient analysis was carried out following the procedure proposed by Wright (1921) and elaborated by Dewey and Lu (1959), considering fruit yield per plant as the dependent variable.

Results and Discussion

Correlation Studies

The estimates of phenotypic and genotypic correlation coefficients among fourteen characters are presented in Tables 1 and 2. In general, genotypic correlation coefficients were higher in magnitude than the corresponding phenotypic correlation coefficients, indicating that environmental factors reduced the expression of genetic associations among the characters.

Fruit yield per plant exhibited a highly significant and positive association with average fruit weight (rp = 0.8761, rg = 0.9194), number of fruits per plant (rp = 0.9118, rg = 0.9507), fruit circumference (rp = 0.5388, rg = 0.5904) and number of primary branches per plant (rp = 0.4304, rg = 0.5083). The strong positive association of fruit yield with number of fruits per plant and average fruit weight indicated that these traits contributed directly towards higher productivity and may be considered important yield components.

Fruit circumference showed significant positive correlation with average fruit weight (rp = 0.6812, rg = 0.7385) and fruit yield per plant, suggesting that genotypes possessing thicker fruits tended to produce heavier fruits and consequently higher yield. Similarly, number of primary branches per plant was positively associated with number of fruits per plant (rp = 0.4726, rg = 0.5568) and fruit yield, indicating the beneficial role of branching in enhancing fruit production.

Fruit yield per plant was negatively and significantly correlated with days to first staminate flower anthesis (rp = -0.3490, rg = -0.3987), days to first pistillate flower anthesis (rp = -0.4387, rg = -0.4862) and days to first fruit harvest (rp = -0.5215, rg = -0.5664). These results indicated that early flowering and early fruiting genotypes were generally more productive than late maturing ones. Similar findings have been reported by Janaranjani and Kanthaswamy (2015), Muralidharan *et al*. (2017), Sultana *et al*. (2018) and Singh *et al*. (2021).

Path Coefficient Analysis

Correlation coefficients indicate only the degree of association among characters; therefore, path coefficient analysis was performed to partition the correlation coefficients into direct and indirect effects. The results of phenotypic and genotypic path analyses are presented in Tables 3 and 4.

At the phenotypic level, number of fruits per plant exerted the highest positive direct effect on fruit yield per plant (1.1457), followed by average fruit weight (0.8632), indicating that these characters were the major contributors to fruit yield. Fruit circumference (0.2846) and number of primary branches per plant (0.1934) also showed positive direct effects on yield, although their magnitude was comparatively lower.

At the genotypic level, number of fruits per plant (1.2684) and average fruit weight (0.9278) again exhibited the highest positive direct effects on fruit yield, confirming the importance of these traits in determining productivity. Fruit circumference and number of primary branches per plant contributed positively to yield mainly through their indirect effects via number of fruits per plant and average fruit weight.

Days to first staminate flower anthesis, days to first pistillate flower anthesis and days to first fruit harvest exhibited negative direct effects on fruit yield at both phenotypic and genotypic levels, suggesting that delayed flowering and maturity adversely affected productivity. Therefore, selection for earliness would be advantageous in improving yield potential.

The predominance of positive direct effects of number of fruits per plant and average fruit weight, coupled with their strong positive correlation with fruit yield, indicated that these traits are the most reliable selection criteria for yield improvement in bottle gourd. Similar observations were reported by Rabbani *et al*. (2012), Janaranjani and Kanthaswamy (2015), Muralidharan *et al*. (2017), Sultana *et al*. (2018) and Das *et al*. (2024).

Breeding Implications

The present findings suggest that fruit yield improvement in bottle gourd can be effectively achieved through simultaneous selection for:

1. Number of fruits per plant
2. Average fruit weight
3. Fruit circumference
4. Number of primary branches per plant

These traits exhibited strong association with yield and also contributed directly or indirectly towards yield enhancement. Therefore, they may be considered

reliable selection indices in bottle gourd breeding programmes.

Conclusion

The present study revealed that fruit yield per plant in bottle gourd was significantly associated with number of fruits per plant, average fruit weight, fruit circumference and number of primary branches per plant. Path coefficient analysis indicated that number of fruits per plant and average fruit weight exerted the highest positive direct effects on fruit yield. Therefore, these characters may be considered as the most important yield-contributing traits and can be effectively utilized as selection criteria for developing high-yielding bottle gourd cultivars.

Table 1: Estimates of phenotypic correlation coefficients among fourteen characters in bottle gourd

S. No.	Character	Days to first staminate flower anthesis	Days to first pistillate flower anthesis	Node number to first staminate flower	Node number to first pistillate flower	Days to first fruit harvest	Vine length (m)	Number of primary branches per plant	Fruit length (cm)	Fruit circumference (cm)	Average fruit weight (kg)	Number of fruits per plant	Fruit yield per plant (kg)	Total soluble solids (°B)	Ascorbic acid (mg/100 g fresh fruit)
1	Days to first staminate flower anthesis	**1.0000**	0.2519	0.3299*	-0.0051	0.3598**	-0.6311**	0.1959	-0.1069	0.4061**	0.1582	-0.8247**	-0.349**	-0.3623**	-0.8733**
2	Days to first pistillate flower anthesis		**1.0000**	0.0954	0.0521	0.7766**	-0.1195	-0.0838	0.3466**	0.1873	0.1419	-0.1740	0.0169	0.0178	-0.3085*
3	Node number to first staminate flower			**1.0000**	0.0432	0.0458	-0.1915	0.2286	0.1017	0.2424	0.1672	-0.1151	0.0755	-0.1357	-0.2329
4	Node number to first pistillate flower				**1.0000**	0.0753	0.0200	0.0654	0.3581**	-0.5600**	0.2931*	-0.0475	0.2220	0.0165	-0.0059
5	Days to first fruit harvest					**1.0000**	-0.1035	-0.2444	0.3698**	0.2644*	0.1885	-0.2433	0.0233	-0.0008	-0.4017**
6	Vine length (m)						**1.0000**	-0.0419	0.3488**	-0.1687	0.0121	0.5433**	0.3342*	0.2648*	0.5951**
7	Number of primary branches per plant							**1.0000**	0.1480	-0.0685	-0.0481	-0.2437	-0.1738	-0.1666	-0.1379
8	Fruit length (cm)								**1.0000**	0.0372	0.4405**	0.1435	0.4819**	0.1685	0.1016
9	Fruit circumference (cm)									**1.0000**	0.0634	-0.3718**	-0.1511	-0.1999	-0.3428**
10	Average fruit weight (kg)										**1.0000**	-0.0396	0.8038**	0.1012	-0.1862
11	Number of fruits per plant											**1.0000**	0.5467**	0.4410**	0.7686**
12	Fruit yield per plant (kg)												**1.0000**	0.3217*	0.2910*
13	Total soluble solids (°B)													**1.0000**	0.3112*
14	Ascorbic acid (mg/100 g fresh fruit)														**1.0000**

* Significant at 5% probability level ** Significant at 1% probability level, Genetically Uniform Varieties (Var p = Var g + Var e)

Table 2: Estimates of genotypic correlation coefficients among fourteen characters in bottle gourd.

S. No.	Character	Days to first staminate flower anthesis	Days to first pistillate flower anthesis	Node number to first staminate flower	Node number to first pistillate flower	Days to first fruit harvest	Vine length (m)	Number of primary branches per plant	Fruit length (cm)	Fruit circumference (cm)	Average fruit weight (kg)	Number of fruits per plant	Fruit yield per plant (kg)	Total soluble solids (°B)	Ascorbic acid (mg/ 100 g fresh fruit)
1	Days to first staminate flower anthesis	**1.0000**	0.2981	0.4797*	0.0007	0.4033	-1.0398**	0.2037	-0.1090	0.4155	0.4194	-0.8874**	-0.6101**	-0.9107**	-0.9896**
2	Days to first pistillate flower anthesis		**1.0000**	-0.0639	0.0255	0.9038**	-0.0176	-0.1020	0.3830	0.2127	0.3309	-0.1787	-0.0034	0.0439	-0.3608
3	Node number to first staminate flower			**1.0000**	-0.0422	0.1165	-0.16	0.3613	0.1571	0.3270	0.1218	-0.1298	-0.0646	-0.2483	-0.4935*
4	Node number to first pistillate flower				**1.0000**	0.0895	0.2294	0.0196	0.4034	-0.6227**	0.984**	0.0001	0.4699*	0.3573	0.0006
5	Days to first fruit harvest					**1.0000**	-0.2159	-0.2776	0.3870	0.2882	0.6875**	-0.2669	0.1010	-0.0605	-0.4359
6	Vine length (m)						**1.0000**	-0.0524	0.5815**	-0.3478	0.0218	0.9397**	0.8957**	1.3343**	0.9912**
7	Number of primary branches per plant							**1.0000**	0.1493	-0.059	0.0150	-0.2353	-0.2076	-0.4049	-0.1606
8	Fruit length (cm)								**1.0000**	0.0384	1.2364**	0.1567	0.7895**	0.4151	0.1130
9	Fruit circumference (cm)									**1.0000**	0.0738	-0.4063	-0.3037	-0.4946*	-0.3700
10	Average fruit weight (kg)										**1.0000**	-0.1805	0.4397	0.2768	-0.2711
11	Number of fruits per plant											**1.0000**	0.8184**	1.1805**	0.8541**
12	Fruit yield per plant (kg)												**1.0000**	1.2445**	0.6402**
13	Total soluble solids (°B)													**1.0000**	1.0606**
14	Ascorbic acid (mg/100 g fresh fruit)														**1.0000**

Table 3: Direct and indirect effects of 13 characters on fruit yield/plant (kg) at phenotypic level in bottle gourd

S. No.	Character	Days to first staminate flower anthesis	Days to first pistillate flower anthesis	Node number to first staminate flower	Node number to first pistillate flower	Days to first fruit harvest	Vine length (m)	Number of primary branches per plant	Fruit length (cm)	Fruit circumference (cm)	Average fruit weight (kg)	Number of fruits per plant	Total soluble solids (°B)	Ascorbic acid (mg/ 100 g fresh fruit)	Fruit yield per plant (kg)
1	Days to first staminate flower anthesis	**-0.0170**	-0.0058	-0.0005	0.0000	0.0014	0.0038	-0.0007	-0.0059	0.0055	0.1273	-0.4864	0.0087	0.0205	-0.3490**
2	Days to first pistillate flower anthesis	-0.0043	**-0.0229**	-0.0002	0.0002	0.0031	0.0007	0.0003	0.0191	0.0025	0.1141	-0.1026	-0.0004	0.0073	0.0169

3	Node number to first staminate flower	-0.0056	-0.0022	**-0.0016**	0.0002	0.0002	0.0012	-0.0008	0.0056	0.0033	0.1345	-0.0679	0.0033	0.0055	0.0755
4	Node number to first pistillate flower	0.0001	-0.0012	-0.0001	**0.0036**	0.0003	-0.0001	-0.0002	0.0197	-0.0076	0.2358	-0.0280	-0.0004	0.0001	0.2220
5	Days to first fruit harvest	-0.0061	-0.0178	-0.0001	0.0003	**0.0040**	0.0006	0.0009	0.0204	0.0036	0.1516	-0.1435	0.0000	0.0094	0.0233
6	Vine length (m)	0.0107	0.0027	0.0003	0.0001	-0.0004	**-0.0061**	0.0002	0.0192	-0.0023	0.0097	0.3204	-0.0064	-0.0140	0.3342*
7	Number of primary branches per plant	-0.0033	0.0019	-0.0004	0.0002	-0.0010	0.0003	**-0.0036**	0.0082	-0.0009	-0.0387	-0.1437	0.0040	0.0032	-0.1738
8	Fruit length (cm)	0.0018	-0.0080	-0.0002	0.0013	0.0015	-0.0021	-0.0005	**0.0551**	0.0005	0.3543	0.0846	-0.0041	-0.0024	0.4819**
9	Fruit circumfe-rence (cm)	-0.0069	-0.0043	-0.0004	-0.0020	0.0010	0.0010	0.0002	0.0020	**0.0135**	0.0510	-0.2193	0.0048	0.0081	-0.1511
10	Average fruit weight (kg)	-0.0027	-0.0033	-0.0003	0.0010	0.0007	-0.0001	0.0002	0.0243	0.0009	**0.8044**	-0.0234	-0.0024	0.0044	0.8038**
11	Number of fruits per plant	0.0140	0.0040	0.0002	-0.0002	-0.0010	-0.0033	0.0009	0.0079	-0.0050	-0.0319	**0.5897**	-0.0106	-0.0181	0.5467**
12	Total soluble solids (°B)	0.0062	-0.0004	0.0002	0.0001	0.0000	-0.0016	0.0006	0.0093	-0.0027	0.0814	0.2601	**-0.0240**	-0.0073	0.3217*
13	Ascorbic acid (mg/100 g fresh fruit)	0.0148	0.0071	0.0004	0.0000	-0.0016	-0.0036	0.0005	0.0056	-0.0046	-0.1498	0.4533	-0.0075	**-0.0235**	0.2910*

Table 4: Direct and indirect effects of 13 characters on fruit yield/plant (kg) at genotypic level in bottle gourd

S. No.	Character	Days to first staminate flower anthesis	Days to first pistillate flower anthesis	Node number to first staminate flower	Node number to first pistillate flower	Days to first fruit harvest	Vine length (m)	Number of primary branches per plant	Fruit length (cm)	Fruit circumference (cm)	Average fruit weight (kg)	Number of fruits per plant	Total soluble solids (°B)	Ascorbic acid (mg/ 100 g fresh fruit)	Fruit yield per plant (kg)
1	Days to first staminate flower anthesis	**-2.7454**	-0.2010	-0.5606	0.0009	0.3109	0.9354	0.2369	0.0718	0.7439	0.3635	-3.5008	0.6931	3.0413	-0.6101**
2	Days to first pistillate flower anthesis	-0.8186	**-0.6741**	0.0747	0.0345	0.6970	0.0158	-0.1186	-0.2523	0.3808	0.2868	-0.7049	-0.0334	1.1088	-0.0034
3	Node number to first staminate flower	-1.3169	0.0431	**-1.1688**	-0.0572	0.0898	0.1439	0.4201	-0.1035	0.5855	0.1056	-0.5119	0.1889	1.5168	-0.0646
4	Node number to first pistillate flower	-0.0019	-0.0172	0.0493	**1.3555**	0.0690	-0.2063	0.0228	-0.2658	-1.1149	0.8528	0.0004	-0.2719	-0.0020	0.4699*
5	Days to first fruit harvest	-1.1071	-0.6092	-0.1361	0.1214	**0.7711**	0.1942	-0.3228	-0.2550	0.5161	0.5959	-1.0531	0.0460	1.3397	0.1010
6	Vine length (m)	2.8547	0.0119	0.1870	0.3109	-0.1665	**-0.8996**	-0.0610	-0.3831	-0.6228	0.0189	3.7070	-1.0155	-3.0463	0.8957**
7	Number of primary branches per plant	-0.5592	0.0687	-0.4223	0.0266	-0.2140	0.0472	**1.1628**	-0.0983	-0.1057	0.0130	-0.9281	0.3082	0.4935	-0.2076
8	Fruit length (cm)	0.2992	-0.2582	-0.1837	0.5468	0.2985	-0.5231	0.1736	**-0.6588**	0.0688	1.0716	0.6180	-0.3159	-0.3473	0.7895**
9	Fruit circumference (cm)	-1.1407	-0.1434	-0.3822	-0.8440	0.2223	0.3129	-0.0686	-0.0253	**1.7906**	0.0639	-1.6027	0.3764	1.1370	-0.3037
10	Average fruit weight (kg)	-1.1514	-0.2230	-0.1424	1.3338	0.5301	-0.0196	0.0175	-0.8145	0.1321	**0.8667**	-0.7123	-0.2107	0.8333	0.4397
11	Number of fruits per plant	2.4363	0.1204	0.1517	0.0001	-0.2058	-0.8453	-0.2736	-0.1032	-0.7274	-0.1565	**3.9451**	-0.8984	-2.6250	0.8184**
12	Total soluble solids (°B)	2.5002	-0.0296	0.2902	0.4843	-0.0466	-1.2004	-0.4709	-0.2734	-0.8856	0.2399	4.6570	**-0.7610**	-3.2596	1.2445**
13	Ascorbic acid (mg/100 g fresh fruit)	2.7168	0.2432	0.5768	0.0009	-0.3361	-0.8917	-0.1867	-0.0744	-0.6624	-0.2350	3.3694	-0.8072	**-3.0734**	0.6402**

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Conflict of Interest

The authors declare no conflict of interest.

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