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Character association and path coefficient analysis of growth, yield and its contributing traits in cucumber (*Cucumis sativus* L.)

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Abstract
The present investigation was carried out at Main Experiment Station, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.). The path coefficient analysis was carried out from phenotypic and genotypic correlation coefficient to resolve direct and indirect effect of different characters on yield. The direct and indirect effect of different characters on yield at phenotypic level and genotypic levels. Both objectives were studied for different characters like-Days to first male (staminate) flower anthesis, Days to first female (pistillate) flower anthesis, Node number to first staminate flower appearance, Node number to first pistillate flower appearance, Number of primary branches per plant, Vine length (m), Days to first fruit harvest, Fruit length (cm), Fruit diameter (cm), Number of fruit per plant, Average fruit weight (g) and Marketable fruit yield per plant (kg). Hence due emphasis should be given to these characters during selection for developing high yielding genotypes in cucumber.

Keywords: Cucumber, path coefficient, correlation coefficient and yield

Introduction
Cucumber (*Cucumis sativus* L.) is a member of family Cucurbitaceae, which comprises of about 120 genera and more than 800 species (Rubatzky and Yamaguchi, 1999). The genus *Cucumis* comprises of about 30 different species in two groups and distributed over two geographically distinct areas. The Asiatic group, to which cucumber belongs, has been found growing wild in the South and East of Himalayas and has diploid chromosome number 2n = 2x = 14 whereas, the African group, including West Indian Gherkin (*Cucumis anguria* L.) and muskmelon (*Cucumis melo* L.) have diploid chromosome number 2n = 2x = 24, have been found wild in Africa and Middle East. The species of one group are genetically and reproductively well isolated from that of other group. Cucumber is in cultivation for last over 3000 years and is thought to be originated in India. It further spread East ward to China and West ward to Asia Minor, North Africa and Southern Europe (Seshadri and Parthasarathy, 2002) [6]. Regarding the ancestral form, Sir Joseph Hooker concluded that Indian wild cucumber (*Cucumis sativus var. hardwickii* Kitamura.) which is found growing wild in the foothills of Himalaya, as either feral or progenitor of present day cucumber. Similar and strong evidence on this aspect was given after six isozyme analysis of Indian wild cucumber carried out by Issihiki *et al*. (1992) [2]. India is the world's second largest producer of vegetables after China, whereas in India it is grown in an area of 0.078 million hectares with a production of 1.142 million tonnes with productivity of 14.64 t/ha (Anonymous, 2017) [1]. For any effective selection programme, it would be desirable to consider the relative magnitude of association of various characters with yield.
Correlation and path coefficient analysis are the important biometrical tools, which are effective for determining the various yield components of different crops leading to selection of superior genotypes. Therefore, for a rational approach for the improvement of yield, it is essential to have information on the association between different yield components and their relative contribution to yield.

Materials and methods
The experiment on the present research work entitled "Character association and path coefficient analysis growth, yield and its contributing traits in cucumber (*Cucumis sativus* L.)"

was conducted at Main Experiment Station, Department of Vegetable Science, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) during summer season of 2018. The experimental material for the present investigation comprised of 28 variable genotypes of cucumber including two check varieties, selected on the basis of genetic variability from the germplasm stock maintained at Main Experiment Station in the Department of Vegetable Science, N.D. University of Agriculture & Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.). The Experiment was laid out in Randomized Block Design (RBD) with 26 genotype and 2 checks. The observation were recorded viz. Days to first male (staminate) flower anthesis, Days to first female (pistillate) flower anthesis, Node number to first staminate flower appearance, Node number to first pistillate flower appearance, Number of primary branches per plant, Vine length (m), Days to first fruit harvest, Fruit length (cm), Fruit diameter (cm), Number of fruit per plant, Average fruit weight (g) and Marketable fruit yield per plant (kg).

Result and discussion

The phenotypic correlation (Table-1.1and 1.2), studies showed that, the character node number of first male flower with node number of first female flower (0.40) significant, days to first male flower anthesis (0.76), days to first female flower anthesis (0.53) and days to first fruit harvest (0.51) highly significant. Node number of first female flower is phenotypic correlation with days to first male flower anthesis (0.62), days to first female flower anthesis (0.61) and days to first fruit harvest (0.56) highly significant. Days to first male flower anthesis had phenotypic correlation with days to first female flower anthesis (0.74) and days to first fruit harvest (0.59) highly significant. Days to first fruit harvest showed phenotypic correlation with number of primary branch per plant (0.14) non significant with positive correlation diameter of fruit (0.19), vine length (0.05) and average fruit weight (0.04). Number of fruit per plant revealed positive significant phenotypic correlation with fruit yield per plant (0.87). The similar findings observed by Singh (1997) [8], Ram *et al.* (2001) [4], Rao *et al.* (2004) [5] and Kumar *et al.* (2008) [3].

Negative and non-significant correlation was observed in vine length with average fruit weight (-0.32), node number of first female flower anthesis with number of fruit per plant (-0.33), days to first male flower anthesis with number of fruit per plant (-0.23), days to first female flower anthesis with number of fruit per plant (-0.20). Diameter of fruit showed negative significant correlation with number of fruits per plant (-0.39).

Path co-efficients analysis was estimated on phenotypic as well as genotypic levels (Table-2.1and 2.2) to resolve the direct and indirect effects of different characters on fruit yield per plant. Maximum positive direct effect on fruit yield per plant exerted by days to first male flower anthesis (0.835) followed by number of primary branch per plant (0.201). At phenotypic level (0.093) positive direct effect on fruit yield was shown by length of fruit followed by vine length (0.036), number of primary branch per plant (0.201), and days to first fruit harvest (0.048). Highest positive indirect effect on fruit yield was shown by days to first male flower anthesis (0.637) via node number of first male flower anthesis followed by number of fruit per plant had indirect positive effect on fruit yield per plant via number of fruit per plant (0.101) followed by diameter of fruit (0.051). The negative indirect effect of node number of first male flower anthesis affected indirectly fruit yield per plant negatively via node number of first female flower anthesis (-0.063) via days to first female flower anthesis (-0.262) and diameter of fruit (-0.150). Days to first fruit harvest affected indirectly fruit yield per plant negatively via days to first female flower anthesis (-0.442) and fruit diameter (-0.094). Average fruit weight affected negatively the fruit yield per plan via days to first female flower anthesis (-0.077). Number of fruit per plant affected negatively the fruit yield per plant via days to first male flower anthesis (-0.190). The similar work done by Tripathi (1997) [9], Sharma and Bhutani (2001) [7], Ying *et al.* (2004) [11] and Veena *et al.* (2011) [10].

Table 1.1: Estimates of phenotypic correlation coefficients different characters in cucumber

Traits	Node No. of first male flower	Node No. of first female flower	Days to first male flower anthesis	Days to first female flower anthesis	Days to first fruit harvest	No. of Primary branch per plant	Length of fruit (cm.)	Diameter of fruit (cm.)	Vine length (m.)	Average fruit weight per (g)	No. of fruit per plant	Fruit yeild (kg) per plant
Node number of first male flower	1.00	0.40*	0.76**	0.53**	0.51**	0.04	0.47*	0.31	0.02	-0.06	-0.14	0.18
Node Number of first female flower		1.00	0.62**	0.61**	0.56**	-0.08	0.21	0.06	0.24	-0.04	-0.33	0.27
Days to first male flower anthesis			1.00	0.74**	0.59**	0.05	0.47*	0.34	-0.05	0.19	-0.23	0.27
Days to first female flower anthesis				1.00	0.89**	0.06	0.11	0.13	-0.01	0.16	-0.20	0.06
Days to first fruit harvest					1.00	0.14	-0.03	0.19	0.05	0.04	-0.17	-0.03
Number of Primary branch per plant						1.00	-0.16	0.10	-0.04	0.12	0.06	0.08
Length of fruit (cm.)							1.00	0.51**	-0.22	0.09	-0.30	0.23
Diameter of fruit (cm.)								1.00	0.04	-0.10	-0.39*	0.08
Vine length (m.)									1.00	-0.32	0.12	-0.10
Average fruit weight per (g)										1.00	0.05	0.28
Number of fruit per plant											1.00	0.87**

Significant at 5% & 1% respectively

Table 1.2: Estimates of genotypic correlation coefficients between different characters in cucumber

Traits	Node No. of first male flower	Node No. of first female flower	Days to first male flower anthesis	Days to first female flower anthesis	Days to first fruit harvest	No. of Primary branch per plant	Length of fruit (cm.)	Diameter of fruit (cm.)	Vine length (m.)	Average fruit weight (g)	No. of fruit per plant	Fruit yeild (kg) per plant
Node No.of first male flower	1.00	0.41	0.85	0.58	0.55	0.02	0.48	0.33	0.02	-0.06	-0.19	0.36
Node No.of first female flower		1.00	0.70	0.66	0.61	-0.09	0.21	0.06	0.24	-0.05	-0.45	0.56
Days to first male flower anthesis			1.00	0.83	0.68	0.03	0.51	0.41	-0.07	0.20	-0.29	0.85
Days to first female flower anthesis				1.00	1.02	0.05	0.12	0.13	-0.01	0.18	-0.26	0.14
Days to first fruit harvest					1.00	0.13	-0.03	0.22	0.06	0.04	-0.30	-0.21

No.of Primary branch per plant						1.00	-0.16	0.11	-0.04	0.15	0.15	0.25
Length of fruit (cm.)							1.00	0.54	-0.23	0.09	-0.40	0.56
Diameter of fruit (cm.)								1.00	0.04	-0.10	-0.55	0.23
Vine length (m.)									1.00	-0.33	0.20	-0.32
Average fruit weight (g)										1.00	0.08	-0.30
Number of fruit per plant											1.00	-2.34

Significant at 5% & 1% respectively

Table 2.1: Direct (bold value) and indirect effects of eleven characters on fruit yield per plant at phenotypic level in cucumber

Traits	Node No. of first male flower	Node No. of first female flower	Days to first male flower anthesis	Days to first female flower anthesis	Days to first fruit harvest	No. of Primary branch per plant	Length of fruit (cm.)	Diameter of fruit (cm.)	Vine length (m.)	Average fruit weight per (g)	No. of fruit per plant	Fruit yield (kg) per plant
Node No.of first male flower	-0.185	-0.063	0.637	-0.262	0.025	0.008	0.044	-0.150	0.001	0.015	0.114	0.18
Node No.of first female flower	-0.074	-0.158	0.517	-0.300	0.027	-0.016	0.019	-0.031	0.009	0.011	0.267	0.27
Days to first male flower anthesis	-0.142	-0.098	0.835	-0.368	0.029	0.010	0.044	-0.170	-0.002	-0.048	0.182	0.27
Days to first female flower anthesis	-0.098	-0.096	0.619	-0.496	0.043	0.012	0.010	-0.062	0.000	-0.039	0.163	0.06
Days to first fruit harvest	-0.095	-0.088	0.495	-0.442	0.048	0.027	-0.003	-0.094	0.002	-0.009	0.132	-0.03
No.of Primary branch per plant	-0.007	0.013	0.041	-0.030	0.007	0.201	-0.015	-0.048	-0.002	-0.031	-0.051	0.08
Length of fruit (cm.)	-0.087	-0.032	0.394	-0.055	-0.001	-0.032	0.093	-0.252	-0.008	-0.023	0.238	0.23
Diameter of fruit (cm.)	-0.057	-0.010	0.287	-0.063	0.009	0.020	0.048	-0.493	0.001	0.026	0.312	0.08
Vine length (m.)	-0.004	-0.037	-0.044	0.005	0.002	-0.008	-0.021	-0.019	0.036	0.081	-0.094	0.10
Average fruit weight per (g)	0.011	0.007	0.159	-0.077	0.002	0.024	0.009	0.051	-0.012	-0.251	-0.042	0.12
No.of fruit per plant	0.026	0.053	-0.190	0.101	-0.008	0.013	-0.028	0.193	0.004	-0.013	-0.797	0.65**

R Square = 0.6606, Residual Effect = 0.5826

Table 2.2: Direct (bold value) and indirect effects of eleven characters on fruit yield per plant at genotypic level in cucumber

Traits	Node No. of first male flower	Node No. of first female flower	Days to first male flower anthesis	Days to first female flower anthesis	Days to first fruit harvest	No. of Primary branch per plant	Length of fruit (cm.)	Diameter of fruit (cm.)	Vine length (m.)	Average fruit weight per (g)	No. of fruit per plant	Fruit yield (kg) per plant
Node No.of first male flower	29.412	18.493	-53.169	-24.173	25.339	-0.157	3.667	7.593	-0.380	-0.997	-5.262	0.36
Node No.of first female flower	12.132	44.832	-43.537	-27.363	28.304	0.658	1.595	1.465	-4.406	-0.781	-12.335	0.56**
Days to first male flower anthesis	25.061	31.280	-62.399	-34.448	31.669	-0.190	3.960	9.310	1.317	3.259	-7.967	0.85**
Days to first female flower anthesis	17.098	29.502	-51.694	-41.582	47.483	-0.329	0.952	2.975	0.099	2.886	-7.249	0.14
Days to first fruit harvest	16.057	27.340	-42.577	-42.540	46.414	-0.914	-0.216	4.927	-1.026	0.704	-8.379	-0.21
No.of Primary branch per plant	0.648	-4.127	-1.657	-1.914	5.941	-7.143	-1.258	2.413	0.793	2.436	4.117	0.25
Length of fruit (cm.)	14.003	9.285	-32.087	-5.139	-1.304	1.167	7.701	12.284	4.212	1.518	-11.083	0.56**
Diameter of fruit (cm.)	9.800	2.882	-25.493	-5.430	10.035	-0.756	4.152	22.787	-0.754	-1.682	-15.309	0.23
Vine length (m.)	0.606	10.716	4.458	0.223	2.584	0.307	-1.760	0.932	-18.434	-5.349	5.402	-0.32
Average fruit weight per (g)	-1.813	-2.166	-12.581	-7.424	2.021	-1.076	0.723	-2.371	6.100	16.166	2.118	0.30
No.of fruit per plant	-5.605	-20.030	18.005	10.918	-14.085	-1.065	-3.091	-12.635	-3.606	1.240	27.610	2.34**

R Square = -89.0838, Residual Effect = 9.4912

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