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Path coefficient analysis in maize (*Zea mays* L.) hybrids

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Abstract
The present experiment consisting 49 maize genotypes was conducted in a randomized complete block design at BHU, Varanasi, and Agriculture farm site with two replicates. Path-coefficient analysis was estimated considering cob yield without husk per plot as dependent trait and the independent characters were seedling emergence%, days to 50% tasseling, days to 50% silking, plant height (cm), ear height (cm), yield with husk per plot (Kg/plot), number of cobs/plot, number of kernel rows per ear, number of kernels per row, ear length (cm), ear width (cm), total soluble solids %, green fodder weight/row (Kg/plot). The genotypic correlation coefficient estimates used to compute direct and indirect effects of thirteen traits on cob yield without husk/plot. Highest positive direct effects on cob yield without husk/plot was exhibited by green fodder weight/plot (2.25), ear width (1.25), plant height (0.70), seedling emergence% (0.61), days to silking (0.46), ear length (0.35), and number of kernels/row (0.25). According to this study, these traits can be used for selection of genotypes with improved yield.

Keywords: cob, kernels, fodder, silking, tasseling, yield

Introduction
Maize (*Zea mays* L.) is known as queen of cereals due to its high genetic potential. Traditionally, maize is a *kharif* crop, but can be grown in all the three seasons. Rabi/spring maize is gaining popularity due to low infestation of pests and diseases. In India, it is the third most important food crops after rice and wheat. However not all this maize is consumed directly by humans? Some of the maize production is used for ethanol production, animal feed and other maize products, such as corn starch and corn syrup. According to current estimate it is cultivated in 9.38 m ha (2017-18) in total in which *Kharif* season covers 80% area. The production of maize in India is 28.75 mt and yield is 3065 Kg/h in 2017-18 (MoA and FW, GOI). Since 1950-51, the area, production and productivity of maize have increased due to increasing maize demand for diversified uses. Despite of such perceptible improvement in maize production in India, the current level of productivity is falling short to meet the demand of rapidly growing population.

Correlation and path coefficient studies between yield and yield components themselves, is a pre-requisite to plan a meaningful breeding programme. Several workers have attempted to determine linkage between the characters on which the selections for high yields can be made and they emphasized the utility of the estimates of genetic components in the response prediction of quantitative characters to selection as well as the correlated response of various traits to grain yield. Sometimes, estimates of correlation coefficients provide misleading results as the correlation between two variables may be due to the involvement of third factor. Also as number of variable increases, the measurement of the contribution of each variable towards the observed correlation is imperative. Therefore, portioning of the observed correlation coefficients into components of direct and indirect influences provide perceptions in the characterizations of more complex traits like yield. Under such condition, path coefficient analysis (Dewey and Lu 1957) [3] which partitions the correlation coefficient, provides precise information on the direct and indirect effects in order to perceive the most influencing characters to be utilized as selection criteria in maize breeding programmes.

Materials and methods
The experiment was conducted at research farm of Banaras Hindu University, Varanasi UP, which is geographically situated between 25'18''N latitude and 83'03''E longitude and an altitude of 75.7 meters above the mean sea level. Varanasi experiences a humid subtropical climate. The experimental material maize F_1 of inbred lines received from Department of Genetics and Plant Breeding, B.H.U, UP. It included 30 sweet corn hybrids, 12 corn hybrids, five QPM_S along with two checks (Table 1).

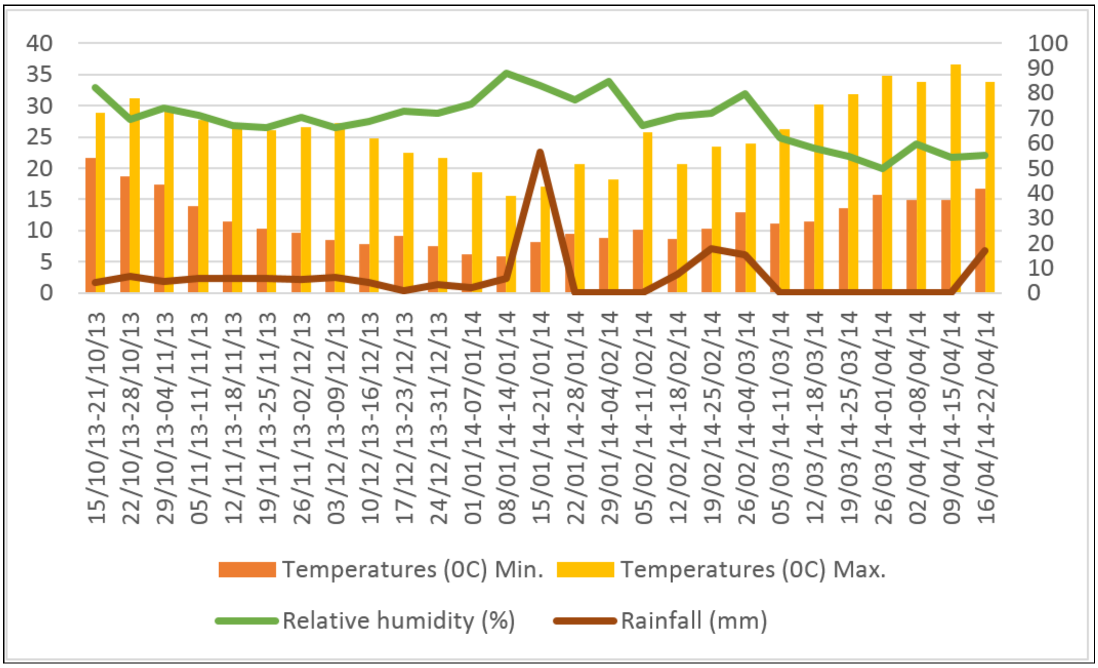
Table 1: List of genotypes of maize studied during investigation

SI. No.	Genotypes of maize
1.	SC female × su2su20202 comp (Red)-BBB-1-BBB 4PI
2.	SC Female × DMSC-1
3.	SC Female × DMSC-8
4.	SC Female x DMSC-9
5.	Su2su20202 comp (y)- BBB-1-BBB 4PI × DMSC-4
6.	Su2su20202 comp (y)- BBB-1-BBB 4PI × DMSC-6
7.	Su2su20202 comp (y)- BBB-1-BBB 4PI × DMSC-8
8.	Su2su20202 comp (y)- BBB-1-BBB 4PI × DMSC-9
9.	Su2su20202 comp (y)- BBB-1-BBB 4PI × DMSC-19
10.	Su2su20202 comp (y)- BBB-1-BBB 4PI × Dulce Amanilla (Su Su)
11.	Su2su20202 comp (y)- BBB-1-BBB 4PI × DMSC-27
12.	Su2su20202 comp (y)- BBB-1-BBB 4PI × DMSC-35
13.	Su2su20202 comp (y)- BBB-1-BBB 4PI × WNCDMRSCO8R686(A)
14.	Su2su20202 comp (y)- BBB-1-BBB 4PI × WNCDMRSCY18R716
15.	Su2su20202 comp (y)- BBB-1-BBB 4PI × Win sweet corn
16.	Su2su20202 comp (y)- BBB-1-BBB 4PI × DMSC-2
17.	Su2su20202 comp (Red) BBB-40-BBB × DMSC-1
18.	Su2su20202 comp (Red) BBB-40-BBB × DMSC-8
19.	Su2su20202 comp (Red) BBB-40-BBB × DMSC-9
20.	Su2su20202 comp (Red) BBB-40-BBB × DMSC-19
21.	DMSC-6 × DMSC-8
22.	DMSC-6 × DMSC-9
23.	DMSC-6 × DMSC-19
24.	DMSC-8 × DMSC-9
25.	DMSC-8 × DMSC-19
26.	DMSC-8 × Dulce Amanilla (Su Su)
27.	DMSC-8 × DMSC-27
28.	DMSC-8 × DMSC-35
29.	DMSC-8 × WNCDMRSCY18R716
30.	HKI-586 × HUZM-69
31.	HUZM-597 × HUZM-355
32.	(CML421 CML170)-B × HUZM-355
33.	(CML421 CML170)-B × HUZM52-1
34.	HUZM-69 × HKI-1025
35.	HUZM-69 × HUZM-246
36.	HUZM-446 × HUZM-355
37.	HUZM-88-2 × HUZM52-1
38.	HUZM-355 × HUZM-358
39.	HUZM52-1 × HUZM-446
40.	HUZM52-1 × HUZM-358
41.	HUZM-246 × HUZM-358
42.	DMSC-8 ×17. Win sweet corn
43.	HKC-193-1× 169(469)
44.	466 ×169
45.	HKC-193-1 × 467
46.	466 × 467
47.	451 (P2) × VQL-1
48.	CHECK 1– WIN ORANGE
49.	CHECK2- MADHURI

The average weekly maximum and minimum temperature, rainfall and Relative humidity during the cropping period represented in Fig. 1.

All F_1 hybrids along with two checks were sown in Randomized Block Design with two replications at Agro-farm of B.H.U during *Rabi* on 11th December 2015. The length of experimental field was 27m and width 8m and each plot measured 4 meter in length and 0.6 meters in width. The spacing of 60cm between rows and 25 cm between plants were maintained and a border of 1.25m width all around the plot. The crop was raised as per the recommended package of practice.

The observations on various pre and post-harvest parameters were recorded on five plants selected at random from each entry in each replication. Harvesting was done on 18th April 2016. Mean of five plants for each entry in each replication was worked out for every character and used for statistical analysis The statistical analysis of data based on the mean value of recorded observations on five random plants, was done for determining the genetic diversity of the hybrid population as well as correlation and regression effects of various traits on yield. The path analysis was carried out by using OPSTAT software (O.P. Sheoran Programmer, Computer Section, CCS HAU, Hisar).



Source: Department of Agronomy, B.H.U, Varanasi (U.P.).

Fig 1: Meteorological data (weekly average) of the crop season, *Rabi* 2015-16

Standard path coefficients which are the standardized partial regressing coefficients were obtained using statistical software packages called GENRES. These values were obtained by solving the following set of 'p' simultaneous equation using the above package.

$P_{01} + P_{02}\, r_{12} + \text{---------} + P_{0P}\, r_{1P} = r_{01}$
$P_{01} + P_{12}\, r_{02} + \text{---------} + P_{0P}\, r_{2P} = r_{02}$
$P_{01} + r_{1P} + P_{02}\, r_{2P} + \text{---------} + P_{0P} = r_{0P}$

Where, P_{01}, P_{02}, -------------- P_{0P} are the direct effects of variables 1,2,--------p on the dependent variable 0 and r_{12}, r_{13}, ------------ r_{1P}--------- $r_{P(P-1)}$ are the possible correlation coefficients between various independent variables and r_{01}, r_{02}, r_{03} ---- r_{0P} are the correlation between dependent and independent variables.

The indirect effect of the i^{th} variable *via* j^{th} variable is attained as ($P_{oj} \times r_{ij}$). The contribution of remaining unknown factor is measured as the residual factor, which is calculated and given below.

$P^2_{ox} = 1-[P^2_{01}+2P_{01}P_{02}r_{12}+2P_{01}P_{03}r_{13}+ \text{------------} + P^2_{02}+ 2P_{02}P_{03}r_{13}+ \text{--------} +P^2_{0P}]$

Residual factor = $\sqrt{(P^2_{ox})}$

Direct or indirect effects are categorized as given below as suggested by Lenka and Mishra 1973 [6].

Negligible - 0.00 to 0.09; Low - 0.10 to 0.19; Moderate 0.20 to 0.29; High - 0.30 to 0.99; Very high - 1.00

Results and discussion

Path-coefficient analysis was studied considering cob yield without husk per plot as dependent trait and the independent characters were seedling emergence%, days to 50% tasseling, days to 50% silking, plant height (cm), ear height (cm), yield with husk per plot (Kg/plot), number of cobs/plot, number of kernel rows per ear, number of kernels per row, ear length (cm), ear width (cm), total soluble solids %, green fodder weight/row (Kg/plot). The genotypic correlation was partitioned into direct and indirect effects on cob yield without husk per plot and the estimate is presented in Table 2.

The path coefficient analysis revealed that the highest positive direct effects on cob yield without husk/plot was exhibited by 61), days to silking (0.46), ear length (0.35), number of kernels/row (0.25), green fodder weight/plot (2.25), ear width (1.25), plant height (0.70), seedling emergence% (0.61), Similar finding had been reported by Yasien *et al.* (2000) [13], Najeeb *et al.* (2009) [8], Munawar *et al.* (2013) [7], Kumar *et al.* (2013) [5], Natraj *et al.* (2014) [9] and Sadiah *et al.* (2014) for number of kernels/row, ear width; Kumar *et al.* (2004) [4] for days to 50% silking and cob length; Saleem *et al.* (2007) [12] and Raghu *et al.* (2011) [10] for plant height, number of rows per cob, ear girth and cob height; Barua *et al.* (2017) [2] for days to 50% silk. Positive significant direct effects of ear width on cob yield can be attributed to greater photosynthate, which could have accumulated in each grain hence giving higher ear diameter. Consequently, this could be part of a good selection index for high yielding maize hybrids. Indirect effects played a minor role on determining yield potential of the hybrids. In contrast, Kumar *et al.* (2004) [4] reported high magnitude of direct effect on grain yield per plant by days to 50% tasseling; Alhadi *et al.* (2013) [1] for ear height and Rafiq *et al.* (2010) for kernel rows per ear. While, cob yield with husk per plot (-1.56), days to 50% tasseling (-1.47), number of kernel rows per ear (-0.70), ear height (-0.57), number of cobs/plot (-0.54) and TSS% (0.20) had direct negative impact on cob yield without husk per plot. These finding corroborate with the finding of Natraj *et al.* (2014) [9] and Sadiah *et al.* (2014) for days to 50% tasseling. Dissimilar finding reported by Jakhar *et al.* (2017) for days to 50% tasseling and Alhadi *et al.* (2013) [1] for ear height, both the traits were reported to have positive direct effect on grain yield of maize.

Table 2: Estimates of Direct and indirect effects for seedling emergence% (SE%), days to 50% tasseling (DTT), days to 50% silking (DTS), plant height (PH), ear height (EH), yield with husk per plot (YWH), number of cobs/plot (NCP), number of kernel rows per ear (NKR), number of kernels per row (NKPR), ear length (EL), ear width (EW), total soluble solids % (TSS%), green fodder weight/row (GF), confronted with the dependent trait cob yield without husk per plot (CY) measured in 49 genotypes of maize.

Effects		Direct effects	Ind. Through SE%	Ind. Through DTT	Ind. Through DTS	Ind. Through PH	Ind. Through EH	Ind. Through YWH	Ind. Through NCP	Ind. Through NKR	Ind. Through NKPR	Ind. Through EL	Ind. Through EW	Ind. Through TSS%	Ind. Through GF	Total
Independent traits	SE%	0.61	-	0.53	-0.15	0.44	-0.28	-1.23	-0.52	-0.25	0.08	-0.08	0.32	-0.10	1.53	0.90
	DTT	-1.47	-0.22	-	0.44	0.13	-0.22	0.11	0.22	-0.03	-0.12	-0.09	-0.22	0.16	0.83	-0.48
	DTS	0.46	-0.20	-1.38	-	0.13	-0.15	0.20	0.20	-0.11	-0.16	-0.16	-0.21	0.15	0.68	-0.55
	PH	0.70	0.38	-0.28	0.09	-	-0.48	-0.56	-0.33	-0.38	-0.03	-0.09	0.00	0.00	1.53	0.55
	EH	-0.57	0.30	-0.56	0.13	0.59	-	-1.06	-0.30	-0.37	0.08	0.02	0.49	0.01	2.23	0.99
	YWH	-1.56	0.48	0.10	-0.06	0.25	-0.39	-	-0.44	-0.01	0.16	0.14	0.78	-0.02	1.55	0.98
	NCP	-0.54	0.59	0.62	-0.18	0.43	-0.32	-1.29	-	-0.09	0.14	0.03	0.34	-0.11	1.37	0.99
	NKR	-0.70	0.22	-0.07	0.07	0.39	-0.30	-0.03	-0.07	-	-0.10	-0.12	0.16	-0.01	0.47	-0.09
	NKPR	0.25	0.20	0.71	-0.29	-0.08	-0.19	-1.03	-0.30	0.29	-	0.12	0.80	-0.13	0.16	0.51
	EL	0.35	-0.14	0.38	-0.21	-0.18	-0.04	-0.61	-0.04	0.23	0.08	-	0.27	-0.02	-0.18	-0.11
	EW	1.25	0.16	0.26	-0.08	0.00	-0.22	-0.98	-0.14	-0.09	0.16	0.08	-	-0.04	0.20	0.56
	TSS%	-0.20	0.31	1.18	-0.36	0.00	0.04	-0.19	-0.29	-0.03	0.16	0.04	0.25	-	-0.32	0.59
	GF	2.25	0.41	-0.54	0.14	0.48	-0.56	-1.07	-0.33	-0.15	0.02	-0.03	0.11	0.03	-	0.76

The seedling emergence% showed highly positive indirect effect for green fodder weight/plot (1.53) followed by days to 50% tasseling (0.53), plant height (0.44) and ear width (0.32) while, it showed negative indirect effect for yield without husk (-1.23) followed by number of cobs/plot (-0.52) and ear height (-0.28).

The days to tasseling observed to have mainly negatively indirect effect for most of the traits except green fodder/plot, days to 50% silking, TSS%, plant height and yield with husk/plot. Days to 50% silking had positive direct effect on cob yield without husk/plot but correlation between these two traits was negatively significant due to its negatively indirect effect via days to 50% tasseling, seedling emergence%, ear width, ear height, ear length, number of kernel rows per ear and number of kernels per row.

The plant height found to have negatively indirect effect for most of the trait except green fodder weight/plot (1.53) and seedling emergence% (0.38). Ear height, cob yield with husk/plot, number of cobs/plot showed negative indirect effect but have significant positive correlation with cob yield without husk/plot due to its significant positive indirect effect for green fodder weight/plot, ear width, and plant height and seedling emergence%.

Number of kernel rows per ear showed negative indirect effect for ear height (-0.30) followed by ear length (-0.12) and number of kernels per row (-0.10). Number of kernels per row exhibited positive indirect effect for ear width (0.80) followed by days to tasseling (0.71) and number of kernel rows (0.29). Ear length had direct positive effect but correlation coefficient with cob yield without husk/plot was negative due to its indirect negative effect for cob yield with husk/plot (-0.61) followed by days to silking (-0.21) and green fodder weight/plot (-0.18).

Ear width found to have significant positive indirect effect for days to 50% tasseling (0.26) followed by green fodder weight/plot (0.20) and seedling emergence% (0.16).

The TSS% content in kernel had showed its indirect positive effect through days to 50 % tasseling (1.18), seedling emergence% (0.31), ear width (0.25) and number of kernels per row (0.16). Green fodder weight/plot observed to have high positive indirect effect for plant height (0.48) followed by seedling emergence% (0.41) and days to 50% silking (0.14). In order to ameliorate cob yield without husk/plot, traits influencing it directly or indirectly should be emphasised. It is crucial to include all the casual factors that affect the cob yield without husk per plot. It's difficult to include all the related factors of yield due to complexity of yield attribute. In the present experiment, the residual effect was 0.034 which indicated the influence of other non-included factors on the cob yield with husk per plot in this study.

References

1. Alhadi RAA, Hadid ML, Al-Ahmad SA. Potence Ratio and Path Analysis for Yield and Quality Traits in Single Crosses of Maize (*Zea mays* L.) Produced in Syria. Jordan Journal of Agricultural Sciences. 2013; 9(2):238-256.
2. Barua NS, Chaudhary VP, Hazarika GN. Genetic variability and correlation studies for morphological traits in maize (*Zea mays* L.) genotypes. Indian Research Journal of Genetics and Biotechnology, 2017; 9(1):38-48.
3. Dewey DR, Lu K. A correlation and path-coefficient analysis of components of crested wheatgrass seed production. Agronomy journal. 1959; 51(9):515-518.
4. Kumar A, Singh NN. Identification of yield contributors through path analysis in maize. Annals of Agricutural Reseach. 2004; 25(3):448-450.
5. Kumar KV, Sudarshan MR, Dangi KS, Reddy SM. Character association and path coefficient analysis for seed yield in quality protein maize (*Zea mays* L.). Journal of Research ANGRAU. 2013; 41(2):153-157.
6. Lenka D, Mishra B. Path coefficient analysis of yield in rice varieties. Indian Journal of Agriculture Science. 1973; 43:376-379.
7. Munawar M, Shahbaz M, Hammad G, Yasir M. Correlation and path analysis of grain yield components in exotic maize (*Zea mays* L.) hybrids. International Journal of Sciences: Basic and Applied Research. 2013; 12(1):22-27.
8. Najeeb SOFI, Rather AG, Parray GA, Sheikh FA, Razvi SM. Studies on genetic variability, genotypic correlation and path coefficient analysis in maize under the high altitude temperate conditions of Kashmir. Maize Genetics Cooperation Newsletter, 2009; 83(3):46-53.
9. Nataraj V, Shahi JP, Agarwal V. Correlation and path analysis in certain inbred genotypes of maize (*Zea mays* L.) at Varanasi. International Journal of Innovative Research and Development. 2014; 3(1):14-17.
10. Raghu B, Suresh J, Kumar SS, Saidaiah P. Character association and path analysis in maize (*Zea mays* L.). Madras Agricultural Journal. 2011; 98(1-3):7-9.
11. Sadaiah K, Reddy VN, Kumar SS. Correlation Studies for Yield and Yield Contributing Characters in Sweetcorn

(*Zea mays* L. *saccharata*). International Journal of Agriculture Innovations and Research. 2013; 2(2):145-148.
12. Saleem A, Saleem U, Subhani GM. Correlation and path coefficient analysis in maize (*Zea mays* L.). Journal of Agricultural Research (Pakistan). 2007; 45(3):177-183.
13. Yasien M. Genetic behaviour and relative importance of some yield components in relation to grain yield in maize (*Zea mays* L). Annals of Agricultural Science, Moshtohor, 2000; 38(2):689-700.