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Vishal Verma
M.Sc. Scholar, Department of Genetics & Plant Breeding, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh, India

MS Yadav
Assistant Professor, Department of Genetics & Plant Breeding, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh, India

Anil Kumar
Ph.D., Scholar, Department of Genetics & Plant Breeding, College of Agriculture, S.K.R.A.U. Bikaner, Rajasthan, India

GS Gathiye
Scientist (Agronomy) RVSKVV-Krishi Vigyan Kendra, Dhar, Madhya Pradesh, India

Corresponding Author:
Vishal Verma
M.Sc. Scholar, Department of Genetics & Plant Breeding, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh, India

Correlation and path analysis for seed yield and components traits in maize (*Zea mays* L.)

Vishal Verma, MS Yadav, Anil Kumar and GS Gathiye

Abstract
A field experiment with 30 maize inbred lines was conducted to study the correlation and path coefficient analysis for seed yield and its component traits in maize at Horticulture Research Farm, Institute of Agricultural Sciences, Bundelkhand University, Jhansi (U.P.) during *Kharif*-2018. Correlation coefficient of seed yield per plant was highly significant and positive with seed yield per cob, number of seed per cob, shelling % and biological yield per plant which indicated that effective improvement in maize yield through these components could be achieved. Path coefficient analysis showed that biological yield per plant, harvest index, seed yield per cob, seed per cob, seeds per row, 100 seed weight, days to 50% germination, cob ear weight, cob length and days to 50% tasseling, days to 50% silking, days to 50% maturity, cobs per plant were the most important characters contributing towards seed yield per plant and selection based on these characters would be more effective for improvement in maize crop.

Keywords: Correlation, maize, path analysis, seed yield

Introduction
Maize or corn (*Zea mays* L.) is one of the most important cereal crops in the world and a strategic food crop for the majority of the developing countries (Lopes and Larkins, 1995) [5]. Being a C_4 plant it has a very high yield potential, probably the highest among the cereal which designates it as ''Queen of Cereals''. It is grown almost in all states of India and occupies a prominent position with regard to area and production. Maize is one of the staple food crops globally. In world, it ranks third next to wheat and husked rice in production and ranks second next to wheat. Maize is predominantly a *Kharif* season crop.
Nutritionally, it rank below wheat and sorghum but considerably above rice containing 10% protein, 4% oil, 70% carbohydrate , 2.3% crude fibre, 10.4% albuminoides and 1.4% ash in grains (Singh, and Bajpai, 1999) [10].
Maize has myriad of uses in food, feed and industrial segment. Globally, 67 percent of maize is used for livestock feed, 25 per cent for human consumption, 14% for starch products, 1% each for beverages and seed and rest for industrial purposes. Thus, maize has attained an important position as industrial crop because 75% of its produce is used in starch and feed industries. In addition to staple food for human being and quality feed for animals, maize serves as a basic raw material and ingredient to thousands of industrial products that includes starch, oil, protein, alcoholic beverages, food sweeteners, pharmaceutical, cosmetic, film, textile, gum, package and paper industries etc.
Correlation coefficient analysis is a statistical technique which measures the degree and association between two or more variables. Estimates of correlation coefficient are useful in identifying the component traits which can be used for yield improvement of maize.
Path coefficient analysis provides a thorough understanding of contribution of various characters by partitioning the correlation coefficient into components of direct and indirect effects (Wright, 1921) [11], which helps the breeder in determining the yield components. To accumulate optimum contribution of yield contributing characters, it is essential to know the association of various characters along with path coefficients (Bhutia *et al.* 2016) [1]. Therefore, present study was conducted to assess correlation and path analysis to identify component traits for developing high yielding varieties of maize.

Material and Methods
The present investigation was carried out during *Kharif*, 2018-19 at Horticulture Research Farm, Institute of Agricultural Sciences, Bundelkhand University; Jhansi (U.P.). The experimental material consisted of 30 maize inbred lines was evaluated in randomized block design with three replications accommodating 3 meters long two rows per replication at 45 cm spacing received from Chandra Shekhar Azad University of Agriculture and Technology Kanpur (U.P.). The name of the genotypes is presented in Table-1.

The observations were recorded for 18 quantitative characters *viz.*, Days to 50% germination, days to 50% flowering, days to 50% silking, days to 50 % tasselling, plant height, leaf/plant, days to 50% maturity, biological yield/plant, cob ear weight, cob length, rows/cob, seeds per row, total seed/cob, 100 seed weight, seed yield per cob, shelling %, harvest index and seed yield per plant.

Observations were recorded on the basis of five random competitive plants selected from each genotype separately for yield and its attributing parameters were evaluated as per the standard procedure suggested by Dewey and Lu (1959) [3].

Result and Discussion

Analysis of variance revealed significant differences among 30 maize inbred lines for all 18 characters studied is presented in (Table 2). The magnitude of genotypic correlation was higher than the phenotypic correlation for all the traits that indicated inherent association between various characters.

Correlation coefficient (Table 3) of seed yield per plant was recorded highly significant and positive with biological yield per plant, cob ear weight, harvest index, seed yield per cob, silking %, plant height, cobs per plant, and seeds per row, indicating that these characters is the primary yield determinant in maize.

Days to 50% germination was recorded highly significant and positive association with number of cobs per plant. Days to 50% tasseling was recorded highly significant and positive association with number of cobs per plant. Days to 50% silking was recorded highly significant and positive association with days to 50% tasseling. Plant height showed significant and Positive correlation with biological yield per plant, rows per cob. Leaves per plant expressed significant and Positive correlation with cobs per plant. Cobs per plant expressed significant and Positive correlation with seeds per row. Days to 50% maturity expressed a highly significant and Positive correlation with seed yield per plant and 100 seed weight. Significant and negative association of days to 50% maturity was observed with seed yield per cob, silking%. The correlation coefficient of biological yield/plant was found significant and positive with seed yield/plant, 100 seed weight, harvest index and cobs per plant. Number of seed per cob expressed significant and positively correlation with harvest index and seed yield per plant. 100 seed weight expressed significant and positive correlation with seed yield per plant and harvest index. These findings are similar to earlier reported by Nagaraju (2012) [6], Nataraj *et al.*, (2014) [7], Ghimire B. and Timsina D. (2015) [4] and Rani *et al.*, (2018) [9].

Path coefficient analysis (Table 4) of different characters contributing towards seed yield per plant showed that biological yield per plant had the highest positive direct effect followed by harvest index, cobs per plant, 100 seed weight, Days to 50% germination, Days to 50% maturity, cob length, Days to 50% tasseling, days to 50% silking, seed per cob.

Path coefficient analysis of different characters contributing towards seed yield per plant Showed on cob length (2.06), days to 50% tasseling (0.53), had highest positive direct effect followed by, days to 50% maturity (0.38). Whereas, while it showed exhibited was highest negative direct effect on seed yield per plant followed by plant height (-1.25), number of leaves per plant (-0.54), cob ear weight (-0.12) showed all direct effect. These findings are similar to earlier reported by Nagaraju (2012) [6], Kumar *et al*., (2015) [12], Ghimire B. and Timsina D. (2015) [4], Prasad, Vara B.V.V. and Shivani, D. (2017) [8], Bisen *et al.*, (2018) [2].

Path coefficient analysis revealed that biological yield per plant, harvest index, silking%, 100 seed weight, total seed per cob, cob length, days to 50% silking and days to 50% maturity, days to 50% tasseling were the most important characters contributing towards seed yield per plant and hence selection and breeding must be concentrated to improve the above mentioned characters in further breeding programme of maize. On the basis of per se performance, CIMMYT-171, D2-2, HYBRID1, 60-828K-CML115, JNY YOFW5 genotypes were found promising for further utilization in maize breeding programme.

Table 1: List of genotypes of understudy

S. No.	Name of Genotypes	S. No.	Name of genotypes
1.	D-7	16.	CIMMYT-171
2.	D 1-2	17.	Hybrid 8
3.	K16/ 1384 A	18.	Hybrid 5
4.	K16/ 1384 B	19.	D-1
5.	Hybrid 6	20.	JNPW WFW 5
6.	IMR 413/ K 16	21.	TSK 11-1
7.	JN Pearl	22.	Hybrid 5
8.	CML-150	23.	REH 2009-12 Hybrid Check
9.	POP-65	24.	TSK11-1
10.	Hybrid 7	25.	DHOLI-M7
11.	D 2-2	26.	D3-3 OSDW 5
12.	D 3-1 YOFW 5	27.	CIMMYT-9
13.	JNY YOFW 5	28.	TSK 11-1
14.	REH 2003 Hybrid check 2	29.	Azad Kamal OFWs
15	60-828K- CML-115	30.	IMR 414/ K16

Table 2: Analysis of variance for eighteen characters of maize genotypes

SN.	Character	Mean Sum of Replications [2]	Square Genotypes [29]	Error [58]
1	Days to 50% Germination	0.03	1.00	0.99
2	Days to 50% Tasseling	1.01	9.91**	4.54
3	Days to 50% Sillking	0.93	2.63	2.23
4	Plant height (cm)	368.81	721.91**	345.04
5	No. of leaves per plant	5.00**	2.09**	0.69
6	No. of Cobs Per Plant	0.04	0.02	0.02
7	Days to 50% Maturity	0.41	4.75**	1.72
8	Biological Yield Per Plant (g)	5536.85	6054.45*	3088.18
9	Cob Ear Weight (g)	193.82	396.59*	220.18
10	Cob length (cm)	3.52	10.54**	4.16
11	No. of Row Per Cob	0.04	1.23	0.83
12	No. of Seed Per Row	10.33	14.03	10.58
13	No. of Seed Per Cob	3094.25	2910.85	2295.94
14	100 Seed Weight (g)	17.45	61.62	51.46
15	Seed Yield Per Cob (g)	128.08	156.66	100.09
16	Seed Yield Per Plant (g)	327.83	187.24	155.72

17	Shelling % in Maize	6.24	58.19	60.33
18	Harvesting Index in Maize	115.88**	21.00	20.17

*, ** Significant at 5% and 1%, respectively

Table 3: Estimates of phenotypic/genotypic correlation coefficient for 18 characters in maize

SN	Character	Days to 50% Germination	Days to 50% Tasseling	Days to 50% Sillking	Plant height (cm)	No. of leaves per plant	No. of Cobs Per Plant	Days to 50% Maturity	Biological Yield Per Plant (g)	Cob Ear Weight (g)	Cob length (cm)	No. of Row Per Cob	No. of Seed Per Row	No. of Seed Per Cob	100 Seed Weight (g)	Seed Yield Per Cob (g)	Seed Yield Per Plant (g)	Shelling %	Harvesting Index
1	Days to 50% Germination		3.59	3.06	0.97**	1.61	9.00	3.90	0.71**	-0.41*	0.01	-6.48**	0.52**	-1.05	1.65	-0.61**	0.56**	9.00	-2.46**
2	Days to 50% Tasseling	-0.15		0.17	0.37*	0.48**	9.00	0.53**	0.59**	0.19	0.23	-0.61**	0.07	-0.59**	-0.35	-0.16	-0.24	9.00	-3.14**
3	Days to 50% Sillking	-0.14	0.22		-0.94**	0.23	9.00	0.05	-1.33	-1.07	-1.04	1.72	-1.78**	-0.76**	-2.26**	-1.00	-0.85**	9.00	4.21
4	Plant height (cm)	0.12	-0.08	0.03		0.94**	9.00	0.45*	1.07	0.85**	0.99**	-0.76**	1.34	1.00	-0.18	1.12	1.74	9.00	-1.18
5	No. of leaves per plant	0.04	0.30	0.16	0.47**		9.00	0.56**	1.07	1.07	0.94**	-0.35	1.00	1.02	0.75**	1.13	1.68	9.00	-0.93**
6	No. of Cobs Per Plant	-0.03	0.35	-0.04	0.24	0.32		9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
7	Days to 50% Maturity	-0.07	0.53**	0.28	0.29	0.34	0.43*		0.49**	0.12	0.27	-0.20	0.07	-0.20	-0.13	-0.07	-0.11	9.00	-2.80**
8	Biological Yield Per Plant (g)	-0.03	0.14	0.06	0.69**	0.55**	0.32	0.33		0.84**	0.96**	-0.78**	1.07	0.65**	0.55**	0.97**	1.22	9.00	-2.02**
9	Cob Ear Weight (g)	-0.01	0.05	0.04	0.61**	0.41*	0.31	0.27	0.66**		0.95**	-1.17	1.24	0.92**	0.57**	1.01	1.30	9.00	-0.77**
10	Cob length (cm)	-0.01	0.20	0.09	0.60**	0.60**	0.38*	0.39*	0.69**	0.65**		-0.54**	1.45	1.07	0.29	1.03	1.45	9.00	-1.05
11	No. of Row Per Cob	-0.16	-0.19	0.06	0.04	-0.01	-0.03	-0.01	0.03	0.18	0.01		-1.78**	-0.74**	-1.83**	-1.37	-2.31**	9.00	-1.67**
12	No. of Seed Per Row	0.13	0.06	-0.11	0.31	0.27	0.37*	0.15	0.42*	0.66**	0.44*	0.17		0.58**	0.22	0.94**	1.23	9.00	-1.56*
13	No. of Seed Per Cob	0.06	-0.03	0.07	0.33	0.28	0.22	0.17	0.42*	0.69**	0.52**	0.39*	0.77**		-0.12	0.89**	1.28	9.00	0.68**
14	100 Seed Weight (g)	-0.10	0.01	-0.11	0.24	0.19	-0.05	0.05	0.10	0.16	0.20	0.10	0.05	0.09		0.85**	1.01	9.00	-1.19
15	Seed Yield Per Cob (g)	0.09	-0.03	-0.08	0.48**	0.33	0.31	0.12	0.58**	0.84**	0.52**	0.27	0.68**	0.79**	0.17		1.15	9.00	-1.95**
16	Seed Yield Per Plant (g)	0.07	0.07	-0.07	0.47**	0.35	0.57**	0.25	0.56**	0.79**	0.52**	0.24	0.69**	0.74**	0.12	0.93**		9.00	-3.69**
17	Shelling % in Maize	0.18	-0.14	-0.20	-0.24	-0.14	-0.02	-0.24	-0.15	-0.25	-0.25	0.20	0.04	0.21	0.01	0.31	0.27		9.00
18	Harvesting Index	0.10	-0.04	-0.13	-0.22	-0.21	0.27	-0.08	-0.40*	0.16	-0.15	0.23	0.32	0.38*	0.02	0.40*	0.51**	0.46*	

*, ** Significant at 5% and 1% respectively.

Table 4: Path analysis showing direct (diagonal) and indirect effects of different correlated characters towards biological yield per plant in maize

SN	Character	Days to 50% Tasseling	Plant height (cm)	No. of leaves per plant	Days to 50% Maturity	Cob Ear Weight (g)	Cob length (cm)	R
1	Days to 50% Tasseling	0.53	-0.47	-0.26	0.20	-0.02	0.60	0.59**
2	Plant height (cm)	0.20	-1.25	-0.51	0.17	-0.10	2.57	1.07
3	No. of leaves per plant	0.26	-1.18	-0.54	0.21	-0.13	2.45	1.07
4	Days to 50% Maturity	0.28	-0.56	-0.30	0.38	-0.01	0.71	0.49**
5	Cob Ear Weight (g)	0.10	-1.06	-0.58	0.05	-0.12	2.46	0.84**
6	Cob length (cm)	0.12	-1.24	-0.51	0.10	-0.11	2.60	0.96**

Significant at 1%.
Residual =0.1736

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