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Genetic parameters and character association study for yield traits in maize (*Zea mays* L.)

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Abstract
The study revealed highly significant differences for all the characters studied, indicating the presence of substantial genetic variability. The phenotypic and genotypic coefficient of variation (PCV and GCV) was high for days to 50% tasseling followed by kernel rows per year and 100 grains weight, respectively. Higher values of broad sense heritability were obtained for almost all the characters except days to 50% tasseling which is moderate. High heritability coupled with high genetic advance as per cent of mean was reported for plant height, grain yield per plant and ear height. However, correlation studies showed that grain yield per plant had significant phenotypic correlation with ear length, whereas, high positive direct effect on grain yield per plant was found to be highest for days to maturity followed by kernel rows per ear, grains per ear revealing that these are the major yield contributing traits in maize.

Keywords: significant, heritability, character, PCV and GCV

Introduction
Maize (*Zea mays* L.) is an important summer crop referred as Queen of cereals (Ali *et al.* 2007) [1]. With a remarkable productive potential among cereals, maize ranks first in the total production followed by wheat and rice (Begum *et al.* 2016) [4]. In India this crop is cultivated in an area of 9.19 million hectares with total net production of 24.17 million tonnes and an average productivity of 26.81 quintals per hectare during 2014-15, but the yield level was low at 2.63 tonnes per hectare compared to world average 5.63 t/ha (USDA. 2016) [22].
Genetic improvement in traits of economic importance, along with maintaining sufficient amount of variability is always the desired objectives in maize breeding programmes (Idris and Abuali. 2011) [11]. The knowledge of heritability establishes appropriate selection methods coupled with the prediction of any grains from selection while also helping to establish the magnitude of the genetic effects. Burton (1952) [6] had suggested that the genetic components of variation together with heritability estimates would give the best picture of amount of genetic advance to be expected from the selection. For improvement in grain yield, it is essential to study the nature of association between yield and its components. Correlation coefficients measure the association between and among two or more traits, whereas path coefficient analysis measures the influence of one trait upon another by means of partitioning both direct and indirect effects. Therefore correlation and path coefficient analysis can determine the appropriate traits to be used in selection for improvement of the complex character such as yield (Ghosh *et al.* 2014) [9]. Keeping in view the above facts, the present investigation in maize was proposed with specific objective to determine genotypic and phenotypic coefficient variation, heritability in broad sense, genetic advance percent of mean, the extent of correlation among traits at both phenotypic and genotypic levels, path coefficient analysis for direct and indirect effect of yield contributing traits on grain yield per plant.

Mathod and Material
The experiment was carried out during summer season 2016 at the Research Farm, Department of Agriculture, Mata Gujri College, Sri Fatehgarh Sahib, Punjab. This place is situated at 73”55’E longitude and 29”30’N latitude at an altitude of 271 meter above sea level in the North Gangetic zone. The experimental material under the study, comprised of 21 diverse genotype of Maize received from Indian Institute of Maize Research, Hyderabad and were raised in randomized block design with three replications. Data were recorded for eleven traits namely days to 50% tasseling, days to 50% silking, days to 75% maturity, plant height (cm), ear height (cm), grain yield per plant (g), 100 grain weight, ear length, ear girth (cm), kernel rows per ear and grains per row. All the recommended package of practices were applied to raise a good and healthy crop. The technique of path coefficient analysis developed by Wright

(1921) [24] and demonstrated by Dewey and Lu (1959) [7] facilitates the partitioning of correlation coefficients into direct and indirect contribution of various characters on yield.

Result and Discussion

The analysis of variance was carried out for all the eleven traits. "F" test calculated that highly significant differences among genotypes for all the traits under investigation indicating ample genetic differences among genotypes.

Table 1: Analysis of variance for yield and yield traits in 21 genotypes of Maize.

Source of Variation	d.f.	Mean sum of squares					
		Days to 50 % tasseling	Days to 50% silking	Days to 75% maturity	Plant Height	Ear Height	Grain Yield per plant
Replication	2	0.506	1.59	4.10	3.20	0.77	1.06
Treatment	20	127.57**	118.38**	177.80**	2279.69**	731.35**	1558.08**
Error	40	29.45	27.24	7.81	43.85	11.89	7.39

* Significant at p=0.05
** Significant at p=0.01

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Source of Variation	d.f.	Mean sum of squares				
		100 Grain weight	Ear length	Ear girth	Kernel rows per ear	Grains per row
Replication	2	0.01	0.05	0.08	0.007	0.11
Treatment	20	84.00**	17.02**	6.44**	5.36**	84.10**
Error	40	2.19	0.44	0.25	0.41	1.43

* Significant at p=0.05
** Significant at p=0.01

Genetic variability, heritability and genetic advances

Phenotypic and genotypic coefficient of variation, heritability (broad sense) and genetic advance are estimated for eleven genotypes and presented in the Table-2.

Grain yield per plant showed range from 38.03 gm (CM 144) to 126.36 gm (CM 131) with a mean of 62.76 indicating a very high range of genetic variability.The high phenotypic and genotypic coefficients of variation for this trait were 36.48 and 36.22, respectively. Similar results are in contrast of Kumar *et al.* (2014) [13]. The heritability estimate for this trait was high (98%) with high genetic advance (46.50), the high expected genetic gain over per cent of mean was 74.09%.Similar observations were recorded by Maruthi and Rani (2015) [15] and Aman *et al*. (2016) [2].

The range of genetic variability observed for ear height (cm) was vary from 44.50 (CM 129) to 99.00 (CM 114) with a mean of 65.69. The phenotypic and genotypic coefficient of variations recorded high for these traits were 24.15 and 23.57, respectively. Begum *et al.* (2016) [4] also reported high magnitude of variation for PCV than GCV which indicated that the apparent variations were not only due to genotypes but also due to environment factors. The observed heritability estimates was very high (95%) with high genetic advance (31.13) and high genetic gain over the per cent of mean (47.40%) indicating the presence of additive gene effects and selection could be effective in early segregating generations for these traits and the possibility of improving maize grain yield through direct selection for grain yield related traits. Similar observations were recorded by Maruthi and Rani (2015) [15].

The range of genetic variability observed for days to 75% maturity varied from 90.83 (CM 145) to 115.33 (CM 120) with a mean of 104.4. The low phenotypic and genotypic coefficients of variation observed for this trait were 7.71 and 7.23, respectively. The observed heritable estimates was very high (87%) with moderate genetic advance (14.53) and moderate genetic gain (13.97%) over per cent of mean. High heritability estimates were also reported by Aman *et al.* (2016) [2], Knife *et al.* (2010) and by several other workers in different studies which are supportive to the current findings.The range of variation for grains per row was 14.50 (CM 133) to 37.40 (CM 138) with a mean of 22.83. The high phenotypic and genotypic coefficients of variation for this trait were 23.57 and 22.98, respectively with high heritability estimate (95%) and moderate genetic advance (10.54) and genetic advance as per cent of mean was high (46.16%).

The range of variation for days to 50% tasseling was 56.50 (CM 144) to 75.50 (CM 137) with a mean of 63.57. The phenotypic and genotypic coefficients of variation for this trait were moderate (12.40) and low (8.99), respectively with moderate heritability estimate (52%) which indicated that tasseling date is moderately influenced by environmental agencies than genotypic differences and very low genetic advance (8.54) and genetic advance as per cent of mean was moderate (13.44%) which is shown in Table-3. The range of variation for days to 50% silking was 58.50 (CM 144) to 77.50 (CM 137) with a mean of 65.69. The phenotypic and genotypic coefficients of variation observed for this trait were moderate (10.13) and low (9.26), respectively. The heritability estimates observed for this trait was high (83%) with moderate genetic advance (11.46) and moderate genetic gain (17.45%) over per cent of mean.

The range of variation for kernel rows per ear was 10.05 (CM 133) to 14.62 (CM 130) with a mean of 12.51. The moderate phenotypic and genotypic coefficients of variation observed for this trait were 11.48 and 10.26, respectively. The heritability estimates observed for this trait was high (79%) with low genetic advance (2.36). and moderate genetic gain (18.90%) over per cent of mean. The lowest value for genetic advance among all the traits under investigation, limits the scope of improvement in this trait through simple selection.

The range of variability observed for ear length (cm) was low. It varied from 9.80 (CM 128) to 18.80 (CM 138) with a mean of 99.03. The moderate phenotypic and genotypic coefficients of variation observed for this trait were 18.92 and 18.20, respectively. The observed heritability estimates for this trait was high (92%) with low genetic advance (4.65) and high genetic gain (36.04%) over per cent of mean.

The range of genetic variability observed for ear girth (cm) was low. It varied from 9.23 (CM 128) to 15.56 (CM 131) with a mean of 12.13. The moderate phenotypic and genotypic coefficients of variation observed for this trait were 12.53 and 11.84, respectively. The observed heritable estimates was high (89%) with low genetic advance (2.73) and high genetic gain (23.03%) over per cent of mean (Table-2).

The range of genetic variability observed for plant height (cm) was high, varying from 99.00 cm (CM 129) to 190 cm (CM 202XCML431) with a mean of 140.34. The moderate phenotypic and genotypic coefficient of variations observed for this trait were 20.01 and 19.45 respectively. Mahmood *et al*. (2004) [16] and Abirami *et al.* (2005) [3] reported high to moderate GCV and PCV value for grain yield and other traits results which indicate influence of environment on genotypes. This trait had high heritability estimates (94%) coupled with high genetic advance (54.65) and high genetic gain over the per cent of mean was 38.94%. Similar observations were recorded by Maruthi and Rani (2015) [15] and Bekele *et al*. (2013).

The range of variation for 100 grain weight was 18.25 (CM 201) to 35.86 (CM 131) with a mean of 23.57. The high phenotypic and genotypic coefficients of variation observed for this trait were 23.03 and 22.15, respectively. Kumar *et al.* (2014) [13] also observed similar results. The heritability estimates observed for this trait was high (92%) with moderate genetic advance (10.34) but the expected genetic gain over per of mean is high (43.90%) which is shown in Table-3. Maruthi and Rani (2015) [15] also observed high heritability with high genetic advance as percant of mean.

Anshuman *et al.* (2013) had reported high heritability coupled with high genetic advance as percent of mean for plant height and grain yield per plant indicated predominance of additive gene action in the expression of these traits.

Table 2: Estimates of genetic parameters for various traits of 21 Maize genotypes

Parameters Characters	Mean ± S.E.	Range		σ^2_p	σ^2_g	PCV (%)	GCV (%)	h^2_{bs} (%)	GA (%)	GA as % of Mean
		Min	Max							
Days to 50% tasseling	63.57±3.13	56.50	75.50	62.16	32.70	12.40	8.99	52	8.54	13.44
Days to 50% silking	65.69±1.55	58.50	77.50	44.29	37.04	10.13	9.26	83	11.46	17.45
Days to 75% maturity	104.04±1.61	90.83	115.33	64.47	56.66	7.71	7.23	87	14.53	13.97
Plant height (cm)	140.34±3.82	99.00	190.00	789.13	745.28	20.01	19.45	94	54.65	38.94
Ear height (cm)	65.69±1.99	44.50	99.00	251.71	239.81	24.15	23.57	95	31.13	47.40
Grain yield per plant (g)	62.76±1.57	38.03	126.36	524.29	516.89	36.48	36.22	98	46.50	74.09
100 grains weight(g)	23.57±0.85	18.25	35.86	29.46	27.26	23.03	22.15	92	10.34	43.90
Ear length(cm)	12.91±0.38	9.80	18.80	5.97	5.52	18.92	18.20	92	4.65	36.04
Ear girth (cm)	12.13±0.28	9.23	15.56	2.31	2.06	12.53	11.84	89	2.79	23.03
Kernel rows per ear	12.51±0.37	10.05	14.62	2.06	1.65	11.48	10.26	79	2.36	18.90
Grains per row	22.83±0.69	14.50	37.40	28.99	27.55	23.57	22.98	95	10.54	46.16

σ^2_p – phenotypic variance; σ^2_g – genotypic variance; PCV – Phenotypic coefficient of variance; GCV – Genotypic coefficient of variance; h^2_{bs} – heritability in broad sense; GA – Genetic advance (at 5% selection intensity i.e. K = 2.06)
2*Values in parenthesis are transformed values.

Table 3: Phenotypic and genotypic contribution to phenotypic correlation for yield and yield traits among 21 genotypes of Maize

Characters		Days to 50 % tasseling	Days to 50 % silking	Days to 75 % maturity	Plant height (cm)	Ear height (cm)	100-grain weight (g)	Ear length (cm)	Ear girth (cm)	Kernel rows/ear	Grains/row	Grain yield/plant (g)
Days to 50% tasseling	G	1.000	1.093	0.941	-0.101	0.064	0.085	-0.285	-0.145	-0.334	-0.345	0.503
	P	1.000	0.867**	0.767**	0.010	0.186	-0.121	-0.038	0.015	-0.515**	-0.177	0.298
Days to 50% silking	G		1.000	0.883	-0.010	0.176	0.099	-0.155	-0.067	-0.399	-0.267	0.439
	P		1.000	0.826**	0.072	0.200	0.033	-0.087	0.074	-0.416**	-0.160	0.379
Days to 75% maturity	G			1.000	0.211	0.297	0.241	0.053	0.053	-0.270	-0.178	0.534
	P			1.000	0.223	0.307*	0.172	0.082	0.100	-0.29**	-0.136	0.481
Plant height (cm)	G				1.000	0.929	0.634	0.674	0.418	-0.042	0.437	0.439
	P				1.000	0.907**	0.560**	0.663**	0.453**	-0.089	0.463**	0.412
Ear height (cm)	G					1.000	0.589	0.601	0.365	-0.074	0.427	0.482
	P					1.000	0.495**	0.618**	0.372**	-0.159	0.428**	0.445
100 grain weight (g)	G						1.000	0.735	0.730	0.176	0.490	0.345
	P						1.000	0.612**	0.619**	0.271	0.432**	0.357
Ear length (cm)	G							1.000	0.674	0.251	0.810	0.479
	P							1.000	0.654**	0.103	0.790**	0.431**
Ear girth (cm)	G								1.000	0.587	0.646	0.424
	P								1.000	0.422**	0.661**	0.380
Kernel rows/ear	G									1.000	0.337	0.038
	P									1.000	0.249*	0.080**
Grains/row	G										1.000	0.398
	P										1.000	0.374**

Correlation/Character Association

The genotypic and phenotypic correlation coefficients estimated between yield and quality traits and inter-correlation among the different yield components and quality traits are furnished and only significant correlations are discussed here. In general, the magnitude of genotypic correlation coefficient was higher than the corresponding phenotypic coefficient indicating thereby a strong inherent association between various traits under study Table- 3.

Days to 50% tasseling showed significantly positive correlation with days to 50% silking (0.867), days to 75% maturity (0.767) and kernel rows per ear (-0.515) shows significantly negative correlation. Golam *et al.* (2011) assessed positive significant correlation of days tasseling with days to silking and days to maturity. Days to 50% silking significantly positive correlated with days to 75% maturity (0.826) and days to 50% tasseling (0.767) while kernel rows per ear (-0.416) is significantly negative correlated. Days to 75% maturity was significantly and positively correlated with days to 50% silking (0.867), whereas significant negative correlation was observed with kernel rows per ear (-0.290).

Plant height showed positive correlation with ear height (0.907), 100 grains weight (0.560), ear length (0.663), ear girth (0.453) and grains per row (0.463) and not showed negative correlation. Tulu (2014) [21] reported that at phenotypic level the correlation of plant height was positive with ear height, ear length and kernels per row which is in line with our findings but they showed negative significant correlation of days to silking with grain yield in contrast correlation is not found in present study.

Ear height showed positive correlation with plant height (0.907), 100 grains weight (0.495), ear length (0.618), ear girth (0.372), grains per row (0.428) and negative correlation not found. They also reported positive and significant phenotypic correlation of ear height with length, ear girth, 100 grains weight and kernels per row hence these yield components can be used as selection criteria to improve grain yield in maize. 100 grains weight showed positive correlation with plant height (0.560), ear height (0.495), ear length (0.612), ear girth (0.619) and grains per row (0.432), whereas negative significant correlation was not observed. Halidu *et al.* (2015) [10] had observed significant and positive correlation of 100 grains weight with ear height and grain yield and plant height shows positive correlation with ear height which favours the experimental finding. Ear length showed positive significant correlation with plant height (0.663), ear height (0.618), 100 grains weight (0.612), ear girth (0.654), grain yield per plant (0.431) and kernel rows per plant (0.790) indicated that cob length had strong and positive genotypic correlation with grain yield per plant. These traits were the key contributors to yield per plant suggesting the need of more emphasis on these component characters for increasing the grain yield in maize. Similar results are reported by Rahman *et al.* (2015) [19] who observed significant and positive correlation of cob length with grain yield per plant at phenotypic levels. Similarly Knife *et al.* (2015) had reported significant and positive correlation for ear height with plant height, ear diameter, number of kernels per row and 100 grains weight, which is supportive to current finding.

Ear girth showed positive significant correlation with plant height (0.453), ear height (0.372), 100 grains weight (0.619), ear length (0.654), kernel rows per ear (0.422) and grains per row (0.661). Such results are in harmony with the findings of Wannows *et al.* (2010) [25]. Similar results were reported by Khazaei *et al.* (2010) [14].

Kernel rows per ear showed significant positive correlation with grains per row (0.249), ear girth (0.422) and grain yield per plant (0.080) and shows negative significant correlation with days to 50% tasseling (-0.515), days to 50% silking (-0.416) and days to 75% maturity (-0.290). Similar to the observations in the present study Sumalini and Manjulatha (2012) [20] reported that the kernel rows per ear had significant positive phenotypic correlation with kernels per row and grain yield per plant. Similarly grains per rows shows positive significant correlation with plant height (0.463), ear height (0.428), 100 grains weight (0.432), ear length (0.790), ear girth (0.661), kernel rows per ear (0.249) and grain yield per plant (0.374).

Correlation studies showed that grain yield per plant had significant phenotypic correlation with ear length. These finding suggested the improvement of the grain yield per plant in maize is linked with the development of cob length traits that might have good impact on grain yield Rahman *et al.* (2015) [19].

Path-Coefficient Analysis

The simple correlation alone, however, is not a true reflection of the nature of association of the different traits with each other when other characters are held constant.The path coefficient analysis is a powerful method in analyzing the scheme of causal relationship in the development of various traits. In the present investigation, the phenotypic correlations of grain yield per plant by means of selected yield traits were partitioned into their corresponding direct and indirect effects through path coefficient analysis.

The phenotypic path-coefficient analysis for the selected component traits are presented in Table-4. Analysis revealed that magnitude of direct effect on grain yield per plant was found to be highest for days to 75% maturity (0.341) followed by kernel rows per ear (0.314), grains per ear (0.306) followed by days to 50% silking (0.278), ear length (0.158), plant height (0.148), ear height (0.046), days to 50% tasseling (0.008). Sumalini and Manjulatha (2012) [20] also reported kernels per ear and grains per row had high positive direct effect on the yield. Rahman *et al*. (2015) [19] reported that number of grains per cob had high direct positive effect on grain yield which is in favour to present study. The findings were also in consonance with reports of Pavan *et al*. (2011) [17]. Similar results are also observed by Rahman *et al.* (2015) [19] which showed that Plant height had direct positive effect on grain yield. Kinfe *et al.* (2015) suggested that ear height also shows direct positive effect on grain yield. Venugopal *et al.* (2003) had reported that days to 50% tasseling have high positive direct effect on grain yield which is in contrast to our finding show low direct positive effect on grain yield. Jalili (2015) in his report concluded that the traits of number of days to maturity have direct positive effect on grain yield.This justifies that the presence of true relationship between these characters and grain yield, there by direct selection through these characters would result reasonable effect on grain yield.

Ear girth (-0.190) and 100 grains weight (-0.012) showed negative direct effects while other traits were observed to be had positive direct effects. Ram Reddy *et al.* (2012) observed that ear girth shows negative direct effect on grain yield These observations are nearly equivalent to Raghu *et al.* (2011) [18] and Devi *et al*. (2001) [8].

Days to 50% tasseling exhibited indirect negative effect via 100 grains weight (-0.001), ear length (-0.003), kernel rows per ear (-0.004) and grains per ear (-0.001) and showed indirect positive effect via days to 50% silking (0.007), days to 75% maturity (0.006), plant height (0.001), ear height (0.0016) and ear girth (0.001). Days to 50% silking showed indirect positive effect on days to 50% tasseling (0.241), days to 75% maturity (0.230), plant height (0.020), ear height (0.055), 100 grains weight (0.009), ear girth (0.020) and exhibited indirect negative effect on ear length (-0.024), kernel rows per ear (-0.116) and grains per row (-0.044). Similar results are in concordance with Knife *et al*. (2015) that days to 50% silking had indirect positive effect on grain yield via days to maturity. Days to 75% maturity exhibited positive indirect effect on days to 50% silking (0.282), days to 50% tasseling (0.261), plant height (0.076) and ear height (0.105) and showed negative indirect effect on kernel rows per ear (-0.116) and grains per ear (-0.046). Plant height exhibited indirect positive effect on ear height (0.134), 100 grains weight (0.083), grains per row (0.068) and ear length (0.098) and showed indirect negative effect on kernel rows per ear (-0.013), similar to Rahman *et al.* (2015) [19] for kernel rows per ear. Ear height showed indirect positive effect on days to 75% maturity (0.014), plant height (0.042), 100 grains weight (0.022), ear length (0.028) and showed indirect negative effect on kernel rows per year (-0.007). Knife *et al.* (2015) observed that ear height have negative indirect effect on kernel rows per ear.

100 grain weight showed indirect positive effect on days to 50% tasseling (0.001) and showed indirect negative effect on plant height (-0.007), ear height (-0.006), ear length(-0.076), ear girth (-0.077) and grains per ear (-0.005). Ear length exhibited indirect positive effect on plant height (0.105), grains per row (0.125), ear girth (0.103) and ear height (0.098) and showed indirect negative effect on days to 50% tasseling(-0.006) and days to 50% silking (-0.013).

Ear girth exhibited indirect negative effect on 100 grains weight (-0.117), ear length (-0.124), grains per ear (-0.126) and ear height (-0.070) and showed no indirect positive effect on any of the trait, whereas, kernel rows per ear showed indirect positive effect on ear girth (0.133), 100 grains weight (0.098) and grains per row (0.078) and exhibited indirect negative effect on days to 50% tasseling (-0.162), days to 50% silking (-0.131), ear height (-0.094). Begum *et al*. (2016) [4] had observed that kernel rows per ear showed negative indirect effect on grain yield with days to tasseling and ear height. Grains per ear showed indirect effect ear length (0.242), ear girth (0.202), plant height (0.142), ear height (0.131) and showed indirect negative effect days to 50% tasseling (-0.054), days to 50% silking (-0.049) and days to 75% maturity (-0.041).

Table 4: Direct and indirect effect (phenotypic) of ten component characters on grain yield per plant in maize

Characters	Days to 50% tasseling	Days to 50% silking	Days to 75% maturity	Plant height (cm)	Ear height (cm)	100-grain weight	Ear length (cm)	Ear girth (cm)	Kernel rows per Ear	Grains per Ear
Days to 50% tasseling	0.0087	0.0076	0.0067	0.0001	0.0016	-0.0011	-0.0003	0.0001	-0.0045	-0.0015
Days to 50% silking	0.2416	0.2786	0.2303	0.0201	0.0558	0.0094	-0.0244	0.0207	-0.1161	-0.0448
Days to 75% maturity	0.2617	0.2820	0.3412	0.0763	0.1050	0.0588	0.0282	0.0343	-0.1021	-0.0465
Plant height (cm)	0.0016	0.0107	0.0332	0.1484	0.1347	0.0832	0.0984	0.0674	-0.0133	0.0689
Ear height (cm)	0.0086	0.0093	0.0142	0.0420	0.0462	0.0229	0.0286	0.0172	-0.0074	0.0198
100-grain weight	0.0015	-0.0004	-0.0022	-0.0070	-0.0062	-0.0125	-0.0076	-0.0077	-0.0034	-0.0054
Ear length (cm)	-0.0061	-0.0139	0.0131	0.1052	0.0981	0.0971	0.1586	0.1037	0.0165	0.1253
Ear girth(cm)	-0.0029	-0.0142	-0.0192	-0.0865	-0.0709	-0.1179	-0.1246	-0.1905	-0.0805	-0.1260
Kernel rows per Ear	-0.1622	-0.1312	-0.0942	-0.0282	-0.0502	0.0853	0.0327	0.1330	0.3148	0.0784
Grains per Ear	-0.0543	-0.0493	-0.0418	0.1421	0.1313	0.1326	0.2421	0.2026	0.0763	0.3063
Grain yield per plant	0.2982	0.3792	0.4814	0.4124	0.4455	0.3578	0.4316	0.3809	0.0803	0.3745
Partial R^2	0.0026	0.1057	0.1642	0.0612	0.0206	-0.0045	0.0684	-0.0726	0.0253	0.1147

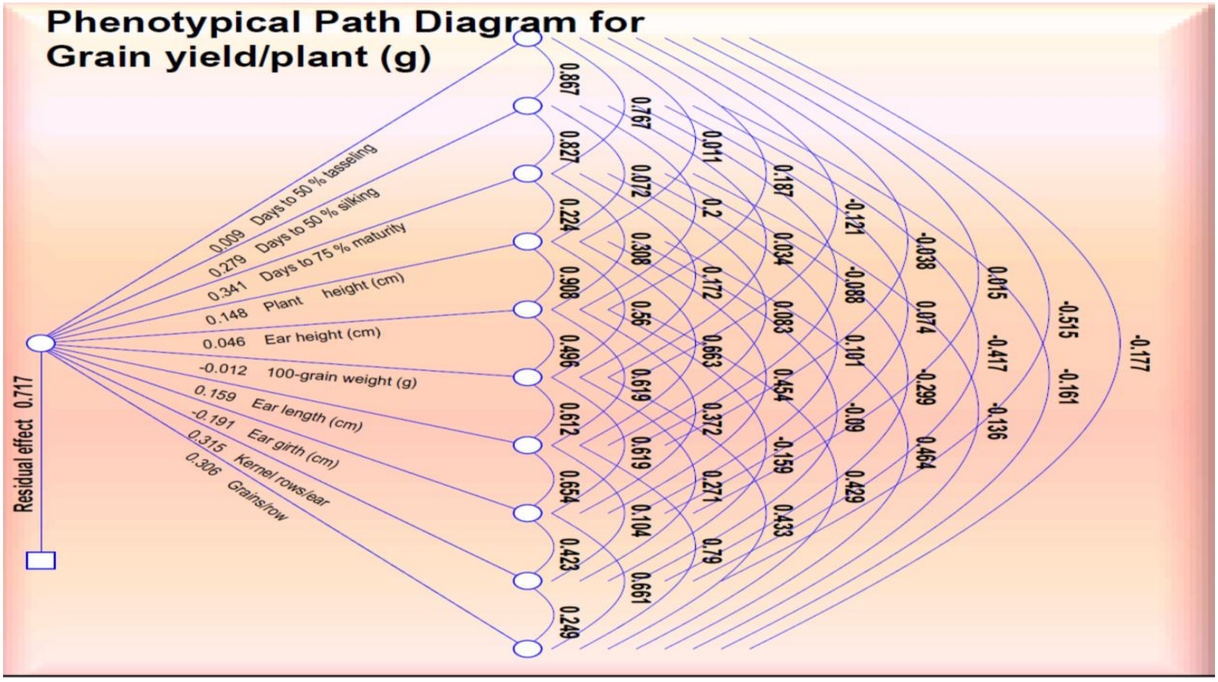

Fig 1: Phenotypical path diagram for grain yield per plant (dependent trait) on 11 selected yield and yield contributing traits.

Conclusion

High heritability coupled with high genetic advance as per cent of mean was reported for plant height, grain yield per plant and ear height.Therefore a simple selection procedure would be helpful in improvement of these traits. Correlation studies showed that grain yield per plant had significant phenotypic correlation with ear length. Strong association of these traits revealed that the selection based on these yield traits would ultimately improve the grain yield. Path coefficient analysis revealed that high positive direct effect on grain yield per plant was found to be highest for days to maturity followed by kernel rows per ear, grains per ear. This justifies that the presence of true relationship between these characters and grain yield there by direct selection through these characters would result reasonable effect on grain yield.

References

1. Ali W, Rehman UH, Ahmad K, Munir I, Khan A. Genetic variability among maize hybrids for yield and yield components. Sarhad J. Agric. 2007; 23(1).
2. Aman J, Bantte K, Alamerew S, Tolera B. Evaluation of Quality Protein Maize (*Zea mays* L) Hybrids at Jimma, Western-Ethiopia. J Forensic Anthropol. 2016; 1:101.
3. Abirami S, Vanniarajan C, Arumugachamy S. Genetic variability studies in maize (*Zea mays* L.) germplasm. Plant Archives. 2005; 5:105-108.
4. Begum S, Ahmed A, Omy SH, Rohman MM, Amiruzzaman M. Genetic variability, character association and path analysis in maize (*Zea mays* L.). Bangladesh J. Agri. Res. 2016; 41(1):173-182.
5. Bello OB, Abdul SY, Afolabi MS, Ige SA. Maize path correlation and path coefficient analysis of yield and agronomic characters among open pollinated maize varieties and their F_1 hybrids in a diallel cross. African Journal of Biotechnology. 2010; 9:2633-2639.
6. Burton GW. Quantitative inheritance in grasses. In: Proceedings of 6th International Grassland Congress. 1952; 1:273-283.
7. Dewey DR, Lu KH. A correlation and path coefficient analysis of components of crested wheat grass seed production. Agronomy Journal. 1959; 51:510-515.
8. Devi IS, Mohammed S, Mohammed. Characters association and path coefficient analysis of grain yield and yield components in double-crosses of maize. Crop Res. Hisar. 2001; 21:355-359.
9. Ghosh A, Subba V, Roy A, Ghosh A, Kundagrami S. Genetic variability and character association of grain yield components in some inbred lines of maize (*Zea mays* L.). Journal of Agroecology and Natural Resource Management. 2014; 1(2):34-39.
10. Halidu J, Abubakar L, Izge UA, Ado SG, Yakubu H, Marker S. Correlation analysis for maize grain yield, other agronomic parameters and striga affected traits under striga infested/free environment. Journal of plant breeding and crop science. 2015; 7(1):9-17.
11. Idris EA, Abuali IA. Genetic variability for vegetative and yield traits in maize (*Zea mays* L.) genotypes. International research Journal of Agricultural sciences and Soil Science. 2011; 1:408-411.
12. Jalili M, Eyvazi P. Comparison of maize hybrids effects on seed traits. Journal of Bio. Diversity and Environmment Science. 2015; 6(1):178-182.
13. Kumar GP, Reddy VN, Kumar SS, Rao PV. Genetic Variability, Heritability and Genetic Advance Studies in Newly Developed Maize Genotypes (*Zea mays* L.). International J. of Bio. Sci. 2014; 2(1):272-275.
14. Khazaei F, MA Alikhani, L Yariand, A Khandan. Study the correlation, regression and path coefficient analysis in sweet corn (*Zea mays* var. Saccharta) under different levels of plant density and nitrogen rate. ARPN J. of Agri. Biol. Sci. 2010; 5(6):14-19.
15. Maruthi RT, Rani KJ. Genetic variability, heritability and genetic advance estimates in maize (*Zeamays*.L). Journal of Applied and Natural Science. 2015; 7(1):149-154.
16. Mahmood Z, Malik SR, Akhtar R, Rafique T. Heritability and genetic advance estimates from maize genotypes in ShishiLusht a valley of Krakurm. International Journal of Agriculture and Biology. 2004; 6:790-791.
17. Pavan R, Lohithaswa W, Shekara. Correlation and path coefficient analysis of grain yield and yield contributing traits in single cross hybrids of maize (*Zea mays* L.). Electronic Journal of Plant Breeding. 2011; 2:253-257.
18. Raghu B, Suresh J, Sudheer Kumar S, Saidaiah P. Character association and path analysis in maize (*Zea mays* L.). Madras Agricultural Journal. 2011; 98(1-3):7-9.
19. Rahman S, Mia MM, Quddus T, Hassan L, Haque MA. Assessing genetic diversity of maize (*Zea mays* L.) genotypes for agronomic traits. Res. Agric. Livest. Fish. 2015; 2(1):53-61.
20. Sumalini K, Manjulatha G. Heritability, correlation and path coefficient analysis in maize. Maize Journal. 2012; 1(2):91-101.
21. Tulu BN. Correlation and path coefficients analysis studies among yield and yield related traits of quality protein maize (QPM) inbred lines. International Journal of Plant Breeding and Crop Science. 2014; 1(2):006-017.
22. USDA. Foreign Agricultural Service. Circular Series WAP, 2016, 6-16.
23. Venugopal M, Ansari NA, Rajanikanth T. Correlation and path analysis in maize (*Zea mays* L.). Crop Research Hisar. 2003; 25:525-529.
24. Wright S. Correlation and causation. Journal of Agricultural Research. 1921; 20:557-585.
25. Wannows AA, Azzam HK, Al- Ahmad SA. Genetics variances, heritability, correlation and path coefficient analysis in yellow maize crosses (*Zea mays* L.). Agric. Biol. J. N. Am. 2010; 1(4):630-637.