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Character Association and Path Analysis for Yield Components and Biochemical Traits in Maize (*Zea mays* L.) Genotypes

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ABSTRACT

Background: Grain yield is a complex character so direct selection for yield as such can be misleading. Keeping in view, the present study aimed to assess the path coefficient analysis with correlation coefficient technique to establish the direct and indirect relationship between the yield and its component.

Methods: The present investigation carried out during *kharif* 2019 at Centurion University of Technology and Management, Odisha in randomized complete block design with 3 replication involving 20 maize genotypes. Data were collected from five randomly selected plnts on 20 agromorphic and biochemical traits. All the biochemical analysis estimated from leaf sample following standard procedure.

Result: The traits shelled grain weight, cob diameter, number of grains per cob and anthesis silking interval were found to possess significant association in disirable direction with five ear weight at both genotypic and phenotypic levels. None of the biochemical trairts establishing significant positive association with yield. Highest positive direct effect on 5 ear weight was noticed by shelled grain weight (1.108) followed by phenols (0.115), internodal length (0.106) and days to 50 percent anthesis (0.102) indicating that the selection for these characters were likely to bring about an overall improvement in grain yield directly.

Key words: Biochemical traits, Correlation analysis, Maize, Path coefficient.

INTRODUCTION

Maize (*Zea mays* L.) is the third most important cereal crop in the India after wheat and rice. India has 5% of corn acreage and contributes 2% of world production (Kumar *et al.,* 2016). Current Agriculture scenario shows, out of total production of maize 67% is used as the animal feed 25% for human consumption and industrial use and balance is used for seed purpose (Reddy *et al.,* 2012). It serves as important source of industrial raw material for the production of various products like oil, starch, gluten, alcoholic beverages, glucose, ethanol, protein, food sweeteners, cosmetics and bio-fuel *etc*. (Parimala *et al.,* 2011). Beside this, maize kernels act as a good source of Thiamin, Niacin, Pantothenic acid (B_5), folate (Alvarez *et al*., 2001), minerals like magnesium and phosphorus (Blair *et al*., 2011), phenolic compounds, flavanoids and antioxidants. Antioxidants and phenols are involved in reactive oxygen species (ROS) content, which plays the protective role and oxidative damage at low moisture content of the seeds.

In India commercial cultivation of maize is gaining importance but its productivity is not up to mark and so identification of high yielding varieties is one of best solution to meet the expectation. In order to achieve this goal, breeders have to select the genotypes based on yield or yield dependent components at the earlier generations as well as in advanced generations. Further, grain yield is a complex and polygenic trait that can be highly influenced by many genetic factors and environmental fluctuations therefore, selection based on the grain yield alone is usually not very effective and efficient. The value of phenotypic and genotypic correlation provides the information about the relationship between the two or more than two independent variables that would be helpful in formulation of an effective selection and screening programme. However, it is not sufficient to describe this relationship of each component with grain yield when more than two variables are involved (Fakorede and Opeke, 1985). So, path analysis is used to estimate the amount of direct effects of specific yield components on yield and indirect effects through other yield components (Nataraj *et al*., 2014; Rajanna *et al*., 2014). Keeping in view, the present research work was therefore, undertaken to understand the association of grain yield with its components and quality traits and to determine the direct and indirect effect of yield attributing traits on yield through path coefficient analysis to develop a suitable selection criterion for future maize breeding program.

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MATERIALS AND METHODS

The experiment was carried out at Centurion University of Technology and Management, Orissa during the *kharif* season 2019. Geographically, the experimental site is located at 23.39°N latitude and 87. 42°E longitude with an elevation of 182.9 m above the mean sea level. The experimental materials consisting of twenty diverse genotypes of maize were grown in randomized complete block design with 3 replications. Each genotype was sown in single line with the spacing of 60 cm between row and 20 cm between plants. All the recommended agronomic and cultural practices were followed throughout the growth period. Representative plants were marked in each replication and close observations were noted regularly.

The data were recorded on 5 randomly selected plants from each entry in all the three replications for the yield components *viz.* plant height (cm), number of leaves, internodal length (cm), number of branches per tassel, number of cobs per plant, ear height (cm), cob length (cm), cob diameter (cm), number of grains per cob, shelled grain weight, 5 ear weight (g), 100 seed weight (g) and various biochemical traits like chlorophyll (mg/g), antioxidants (%), flavonoids (mg/) and phenols (mg/g). The observation on days to 50% tasseling, days to 50% silking, anthesis silking interval and days to maturity were noted on plot basis.

All the biochemical parameters of different genotypes were estimated independently from the leaves sample in replicated way. Total flavonoid content was estimated following Aluminum Chloride Colori-metric method (Chang *et al*., 2002). The extraction of total chlorophyll using acetone as the main ingredient was estimated as per the Srichaikul *et al*. (2011). Subsequently, total antioxidant activity (TAA) was determined by 1, 1-diphenyl 1-2-picrylhydrazl (DPPH) method suggested by Brand-Williams *et al*. (1995) and the concentration of total phenol content in plant extracts was estimated spectrophotometrically as per the protocol of Singleton *et al*. (1999). The standardized traits mean values were pooled and subjected for statistical analysis to assess the correlation (Singh and Chaudhary, 1979) and path analyses (Dewey and Lu, 1959) using INDOSTAT version 8.1 (IndoStat Inc. Hyderabad, India).

RESULTS AND DISCUSSION

The phenotypic and genotypic correlation coefficients among yield and yield attributing traits are presented in Table 2. The results showed that the rG in general were higher than their corresponding rP which pertains to a strong inheritance of traits and least influence of environment on phenotypic expression. Similar observation was reported by Nataraj *et al.* (2014). A close observation of the characters under study indicated 5 ear weight had significant positive correlation with the shelled grain weight, cob diameter, number of grains per cob and anthesis silking interval at both genotypic and phenotypic level. Therefore, selection would be effective for simultaneous improvement for these traits. Similar results were reported earlier by several workers employing association of 5 ear weight with different characters like cob diameter (Kote *et al.,* 2014 and Huda *et al.,* 2016), shelled grain weight (Kumar and Satyanarayana, 2001 and Jabeen, 2005), number of grains per cob (Raghu *et al.,* 2011) and anthesis silking interval (Saidaiah *et al.,* 2008 and Panwar *et al.,* 2013). Further, 5 ear weight showed negative but nonsignificant association with number of cobs per plant, total chlorophyll, flavonoids and antioxidants which stipulates the independent nature between these traits.

Inter correlation among the yield components were significant and observed in both positive and negative direction at the genotypic and phenotypic level. Plant height associated significantly and positively with number of leaves, internodal length, days to 50% anthesis, days to 50% silking, days to maturity and cob length. Similar findings were reported earlier by Tulu (2014) and Singh *et al.* (2017).

Number of leaves positively correlated with internodal length, days to 50% anthesis, days to 50% silking and number of grains per cob. Internodal length positively associated with days to 50% anthesis, days to 50% silking, cob length and phenol content while negatively related to ear height and chlorophyll content. Similar findings reported previously by Knife *et al.* (2015).

Days to 50% anthesis and days to 50% silking exhibited significant positive association with days to maturity, cob length and phenol content and had negative association with chlorophyll content and total antioxidant. Further, they had very strong positive correlation with each other which is in strong agreement of earlier result of Kumar *et al*. (2016) and Singh *et al*. (2017).

Number of cobs per plant had significant positive association with number of branches per tassel and flavonoids. Cob length and cob diameter had positive and negative association respectively with shelled grain weight and total chlorophyll content. Alongside, they were strongly correlated with each other in positive way.

Number of grains per cob was positively correlated with number of leaves, shelled grain weight and phenol contents. Shelled grain weight had positive and significant association with anthesis silking interval, cob diameter and cob length. Rahman *et al*. (2015) reported significant positive correlation between shelled grain weight and cob length is in accordance with present findings. Whereas, 100 grain weight had nonsignificant association with all the traits mainly in negative direction except chlorophyll content where it was significantly associated in negative way.

All the biochemical traits exhibited nonsignificant association with 5 ear weight and with most of the other yield components. Total chlorophyll had significant negative association with most of the traits and no significant positive correlation was noticed with any of the characters. Flavonoids had significant positive relationship with the number of cobs, cob diameter and antioxidant but on the contrary it had negative and significant association with 100 grain weight and phenol content. Similarly, traits like Kumar,

Table 1: Estimation of phenotypic (P) and Genotypic (G) correlation coefficient for twenty yield related and biochemical traits in maize genotypes.

Characters		PH	NL	INL	DA	DS	ASI	NBT	NCP	EH	DM	CD	CL	NGC	SGW	100GW	TC	FLV	PHN	AO
PH	P	1.000	0.316*	0.586***	0.539***	0.541***	-0.116	0.113	-0.034	-0.065	0.468***	0.167	0.472***	-0.138	0.079	-0.030	-0.304*	0.133	-0.147	-0.122
	G	1.000	0.435	0.699	0.588	0.583	-0.131	0.221	-0.033	-0.172	0.492	0.202	0.508	-0.138	0.085	-0.015	-0.310	0.161	-0.155	-0.133
NL	P		1.000	0.411**	0.389**	0.383**	-0.172	-0.15	0.038	0.203	0.235	0.167	0.198	0.268*	0.227	0.012	-0.257*	0.017	-0.069	-0.226
	G		1.000	0.567	0.442	0.423	-0.330	-0.151	-0.108	0.346	0.292	0.289	0.232	0.276	0.268	-0.016	-0.308	0.065	-0.110	-0.310
INL	P			1.000	0.374**	0.460***	0.025	0.057	0.049	-0.285*	-0.037	0.134	0.402**	0.151	0.155	0.123	-0.255*	-0.163	0.267*	-0.105
	G			1.000	0.520	0.596	0.188	0.138	-0.199	-0.446	-0.014	0.088	0.438	0.212	0.186	0.167	-0.354	-0.114	0.327	-0.143
DA	P				1.000	0.924***	-0.045	0.187	-0.004	-0.238	0.379**	0.133	0.371**	0.031	0.145	-0.154	-0.306*	-0.156	0.260*	-0.503***
	G				1.000	0.980	0.066	0.315	-0.228	-0.299	0.398	0.204	0.406	0.026	0.154	-0.155	-0.339	-0.194	0.274	-0.532
DS	P					1.000	0.242	0.254*	0.039	-0.295*	0.262*	0.137	0.354**	0.080	0.252	-0.124	-0.321*	-0.226	0.389**	-0.557***
	G					1.000	0.266	0.340	0.020	-0.367	0.275	0.209	0.355	0.069	0.264	-0.124	-0.364	-0.232	0.404	-0.581
ASI	P						1.000	0.225	0.182	-0.290*	-0.305*	0.077	0.056	0.186	0.269*	0.009	-0.045	-0.132	0.457***	-0.079
	G						1.000	0.378	0.565	-0.610	-0.523	0.119	0.024	0.298	0.426	-0.014	-0.086	-0.282	0.796	-0.119
NBT	P							1.000	0.262*	-0.265*	-0.211	0.046	0.312*	-0.163	0.096	-0.204	-0.305*	0.174	0.017	0.074
	G							1.000	0.643	-0.372	-0.276	0.099	0.358	-0.197	0.118	-0.297	-0.440	0.220	0.017	0.097
NCP	P								1.000	-0.006	-0.102	-0.135	-0.113	-0.070	0.058	-0.069	0.150	0.270*	-0.055	-0.035
	G								1.000	0.095	-0.368	-0.530	-0.357	-0.130	0.137	-0.109	0.316	0.663	-0.098	-0.115
EH	P									1.000	0.242	-0.043	-0.262*	-0.057	0.074	-0.061	0.070	0.081	-0.482***	-0.183
	G									1.000	0.308	0.116	-0.302	-0.098	0.085	-0.118	0.139	0.088	-0.630	-0.240
DM	P										1.000	0.142	0.224	-0.064	0.104	-0.092	-0.203	0.208	-0.384**	-0.219
	G										1.000	0.180	0.237	-0.066	0.105	-0.101	-0.206	0.206	-0.382	-0.228
CD	P											1.000	0.614***	0.183	0.516***	-0.098	-0.334**	0.277*	-0.095	-0.155
	G											1.000	0.742	0.236	0.634	-0.114	-0.385	0.371	-0.108	-0.197
CL	P												1.000	0.230	0.312*	0.019	-0.462***	0.210	0.016	-0.006
	G												1.000	0.248	0.325	0.025	-0.500	0.252	0.023	-0.005
NGC	P													1.000	0.411**	0.066	-0.369**	0.045	0.411**	0.036
	G													1.000	0.422	0.060	-0.395	0.057	0.420	0.043
SGW	P														1.000	0.138	-0.336**	0.094	0.011	-0.230
	G														1.000	0.140	-0.349	0.096	0.012	-0.233
100 GW	P															1.000	0.143	-0.256*	0.142	0.067
	G															1.000	0.175	-0.261	0.143	0.078
TC	P																1.000	-0.052	-0.010	0.167
	G																1.000	-0.047	-0.014	0.176
FLV	P																	1.000	-0.483***	0.384**
	G																	1.000	-0.512	0.418
PHN	P																		1.000	-0.272*
	G																		1.000	-0.281
AO	P																			1.000
	G																			1.000
5EW	P	0.005	0.121	0.158	0.110	0.211	0.276*	0.034	0.012	0.017	0.059	0.473***	0.246	0.393**	0.964***	0.089	-0.245	0.000	0.092	-0.207
	G	0.002	0.150	0.176	0.106	0.221	0.485***	0.051	-0.015	0.023	0.062	0.567 ***	0.254*	0.409**	0.971***	0.102	-0.255*	-0.002	0.094	-0.212

Table 2: Phenotypic (P) and Genotypic (G) direct (diagonal) and indirect effects of component traits attributing to grain yield in maize.

Characters		PH	NL	INL	DA	DS	ASI	NBT	NCP	EH	DM	CD	CL	NGC	SGW	100GW	TC	FLV	PHN	AO
PH	P	-0.066	-0.021	-0.039	-0.036	-0.036	0.007	-0.007	0.002	0.004	-0.031	-0.011	-0.031	0.009	-0.005	0.002	0.020	-0.008	0.009	0.008
	G	-0.493**	-0.214**	-0.345**	-0.290**	-0.288**	0.065	-0.109	0.016	0.085	-0.243**	-0.099	-0.250**	0.068	-0.042	0.007	0.153	-0.079	0.076	0.066
NL	P	-0.027	-0.086	-0.035	-0.033	-0.033	0.014	0.013	-0.003	-0.017	-0.020	-0.014	-0.017	-0.023	-0.019	-0.001	0.022	-0.001	0.005	0.019
	G	-0.424**	-0.976**	-0.554**	-0.432**	-0.413**	0.323**	0.147	0.105	-0.338**	-0.286**	-0.283**	-0.227**	-0.269**	-0.261**	0.016	0.301**	-0.064	0.108	0.303**
INL	P	0.062	0.043	0.106	0.040	0.049	0.002	0.006	0.005	-0.030	-0.004	0.014	0.043	0.016	0.016	0.013	-0.027	-0.017	0.028	-0.011
	G	0.904**	0.733**	1.293***	0.673**	0.772**	0.244**	0.179	-0.257**	-0.576**	-0.018	0.114	0.567**	0.275**	0.241**	0.216**	-0.458**	-0.148	0.423**	-0.185
DA	P	0.055	0.039	0.038	0.102	0.094	-0.004	0.019	-0.000	-0.024	0.038	0.013	0.038	0.003	0.014	-0.015	-0.031	-0.016	0.026	-0.051
	G	0.392**	0.295**	0.347**	0.667**	0.654**	0.044	0.211**	-0.152	-0.199	0.266**	0.136	0.271**	0.017	0.103	-0.103	-0.226**	-0.130	0.183	-0.355**
DS	P	-0.089	-0.063	-0.076	-0.153	-0.165	-0.040	-0.042	-0.006	0.049	-0.043	-0.022	-0.058	-0.013	-0.041	0.020	0.053	0.037	-0.064	0.092
	G	-0.298**	-0.216**	-0.305**	-0.501**	-0.511**	-0.136	-0.174	-0.010	0.187	-0.140	-0.107	-0.181	-0.035	-0.135	0.063	0.186	0.118	-0.207**	0.297**
ASI	P	0.001	0.002	-0.000	0.000	-0.003	-0.013	-0.003	-0.002	0.004	0.004	-0.001	-0.000	-0.002	-0.003	-0.000	0.000	0.001	-0.006	0.001
	G	0.024	0.060	-0.034	-0.012	-0.048	-0.182	-0.069	-0.103	0.111	0.095	-0.021	-0.004	-0.054	-0.077	0.002	0.015	0.051	-0.145	0.021
NBT	P	-0.006	0.009	-0.003	-0.010	-0.014	-0.013	-0.058	-0.015	0.015	0.012	-0.002	-0.018	0.009	-0.005	0.011	0.017	-0.010	-0.001	-0.004
	G	0.078	-0.053	0.048	0.111	0.119	0.133	0.351**	0.226**	-0.131	-0.097	0.034	0.125	-0.069	0.041	-0.104	-0.155	0.077	0.006	0.034
NCP	P	0.000	-0.000	-0.000	0.000	-0.000	-0.003	-0.004	-0.017	0.000	0.001	0.002	0.002	0.001	-0.001	0.001	-0.002	-0.004	0.001	0.000
	G	0.005	0.019	0.035	0.040	-0.003	-0.099	-0.113	-0.175	-0.016	0.064	0.093	0.062	0.022	-0.024	0.019	-0.055	-0.116	0.017	0.020
EH	P	0.001	-0.005	0.007	0.006	0.007	0.007	0.006	0.000	-0.025	-0.006	0.001	0.006	0.001	-0.001	0.001	-0.001	-0.002	0.012	0.004
	G	-0.160	0.321**	-0.413**	-0.277**	-0.340**	-0.566**	-0.346**	0.088	0.928**	0.285**	0.108	-0.280**	-0.091	0.079	-0.110	0.129	0.082	-0.585**	-0.223**
DM	P	0.031	0.016	-0.002	0.025	0.017	-0.020	-0.014	-0.007	0.016	0.067	0.009	0.015	-0.004	0.007	-0.006	-0.013	0.014	-0.026	-0.014
	G	0.153	0.091	-0.004	0.124	0.085	-0.163	-0.086	-0.114	0.096	0.311**	0.056	0.073	-0.020	0.033	-0.031	-0.064	0.064	-0.119	-0.071
CD	P	-0.003	-0.003	-0.002	-0.002	-0.002	-0.001	-0.001	0.002	0.000	-0.003	-0.020	-0.012	-0.003	-0.010	0.002	0.007	-0.005	0.002	0.003
	G	0.035	0.051	0.015	0.036	0.036	0.021	0.017	-0.093	0.020	0.031	0.176	0.131	0.041	0.112	-0.020	-0.068	0.065	-0.019	-0.034
CL	P	-0.000	-0.000	-0.000	-0.000	-0.000	0.000	-0.000	0.000	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.000	0.000	-0.000	0.000	0.000
	G	-0.195	-0.089	-0.168	-0.156	-0.136	-0.009	-0.137	0.137	0.116	-0.091	-0.285**	-0.384**	-0.095	-0.124	-0.009	0.192	-0.096	-0.008	0.002
NGC	P	0.009	-0.018	-0.010	-0.002	-0.005	-0.013	0.011	0.004	0.004	0.004	-0.012	-0.016	-0.069	-0.028	-0.004	0.025	-0.003	-0.028	-0.002
	G	0.007	-0.015	-0.011	-0.001	-0.003	-0.016	0.011	0.007	0.005	0.003	-0.013	-0.014	-0.056	-0.023	-0.003	0.022	-0.003	-0.023	-0.002
SGW	P	0.088	0.252**	0.172	0.161	0.279**	0.298**	0.106	0.064	0.083	0.116	0.572**	0.346**	0.456**	1.108***	0.153	-0.372**	0.105	0.012	-0.255**
	G	0.096	0.302**	0.210**	0.174	0.298**	0.481**	0.133	0.155	0.096	0.119	0.716**	0.366**	0.476**	1.128***	0.158	-0.394**	0.109	0.014	-0.263**
100	P	0.004	-0.001	-0.017	0.022	0.017	-0.001	0.029	0.009	0.008	0.013	0.014	-0.002	-0.009	-0.019	-0.142	-0.020	0.036	-0.020	-0.009
GW	G	0.003	0.000	-0.009	0.008	0.006	0.000	0.016	0.006	0.006	0.005	0.006	-0.001	-0.003	-0.007	-0.054	-0.009	0.014	-0.007	-0.004
TC	P	-0.018	-0.015	-0.015	-0.018	-0.019	-0.002	-0.018	0.009	0.004	-0.012	-0.020	-0.028	-0.022	-0.020	0.008	0.061	-0.003	-0.000	0.010
	G	-0.050	-0.049	-0.057	-0.054	-0.058	-0.014	-0.071	0.051	0.022	-0.033	-0.062	-0.080	-0.063	-0.056	0.028	0.161	-0.007	-0.002	0.028
FLV	P	-0.012	-0.001	0.015	0.014	0.020	0.012	-0.016	-0.024	-0.007	-0.019	-0.025	-0.019	-0.004	-0.008	0.023	0.004	-0.091	0.044	-0.035
	G	0.043	0.017	-0.031	-0.052	-0.062	-0.076	0.059	0.179	0.024	0.055	0.100	0.068	0.015	0.026	-0.070	-0.012	0.270**	-0.138	0.113
PHN	P	-0.017	-0.008	0.031	0.030	0.045	0.053	0.002	-0.006	-0.055	-0.044	-0.011	0.001	0.047	0.001	0.016	-0.001	-0.056	0.115	-0.031
	G	-0.090	-0.064	0.189	0.158	0.234**	0.461**	0.010	-0.057	-0.365**	-0.221**	-0.062	0.013	0.243**	0.007	0.082	-0.008	-0.296**	0.579**	-0.163
AO	P	-0.008	-0.015	-0.007	-0.034	-0.038	-0.005	0.005	-0.002	-0.012	-0.015	-0.010	-0.000	0.002	-0.015	0.004	0.011	0.026	-0.018	0.068
	G	-0.027	-0.063	-0.029	-0.109	-0.119**	-0.024	0.019	-0.023	-0.049	-0.046	-0.040	-0.001	0.008	-0.047	0.016	0.036	0.085	-0.057	0.204**
5EW	P	0.005*	0.121*	0.158*	0.110	0.211**	0.276**	0.034	0.012	0.017	0.059	0.473**	0.246**	0.393**	0.964**	0.089	-0.245**	0.000	0.092	-0.207**
	G	0.002	0.150*	0.176*	0.106*	0.221**	0.485**	0.051	-0.015	0.023	0.062	0.567**	0.254**	0.409**	0.971**	0.102*	-0.255**	-0.002	0.094	-0.212**

Phenotypic residual effect = 0.1390, Genotypic residual effect= -0.0504, PH: Plant height (cm), NL: Number of leaves, INL: Inter nodal length (cm), DA: Days for 50% anthesis, DS: Days for 50% silking, ASI: Anthesis silking interval, NBT: Number of branches of tassel, NCP: Number of cobs per plant, EH: Ear height (cm), DM: Days to maturity, CD: Cob diameter (cm), CL: Cob length (cm), NGC: Number of grains per cob, SGW: Shelled grain weight (g), 100 GW: 100 grain weight (g), TC: Total chlorophyll (mg/g), FLV: Flavanoids (mg/g), PHN: Phenols (mg/g), AO: Antioxidants (mg/g), 5 EW: 5 Ear weight (mg/g).

internodal length, days to 50% anthesis, days to 50% silking, anthesis silking interval and number of grains per cob exhibited significant positive association with phenol while, ear height, days to maturity and antioxidant (%) was negatively correlated with it. Antioxidant (%) was mainly interrelated negatively with most of the characters either nonsignificant or significant way (days to 50% anthesis, days to 50% silking and phenol). Similar results were found by Bikal *et al.* (2015); Haslina and Eva (2017) and Kumar *et al.* (2012) in maize.

It was obvious from Table 2 that shelled grain weight had a high positive direct effect on the dependent character 5 ear weight. The traits like inter nodal length, days for 50% anthesis and phenols resulted with the low positive direct effect to the 5-ear weight. Negligible positive and direct effect was recorded for days to maturity, total chlorophyll and antioxidants. Presence of high to low direct effect of these characters on yield indicates the existence of true relationship between these characters and grain yield, thereby direct selection through these traits would result reasonable effect on grain yield. A highly significant and positive direct effect of shelled grain weight on five ear weight was reported by Sumalini and Manjulatha (2012) while, Jalili and Eyvazi (2015) indicated high positive direct effect of days to 50% anthesis and days to maturity towards grain yield which are in consent to the present finding.

Negative direct effects on 5 ear weight at genotypic level only were attributed by plant height, number of leaves, days to 50% silking and cob length whereas,100 grain weight had low negative direct effect at both genotypic and phenotypic level which specified that selection for high grain yield can be done by indirect selection through yield components. Direct negative effect of different yield attributing traits like plant height (Kumar *et al.*, 2016), cob length (Nataraj *et al.,* 2014) and 100 grains weight (Reddy *et al.,* 2012) on grain yield were reported earlier which are in accordance with the present findings.

Conclusion

It can be concluded from the present investigation that shelled grain weight, cob diameter, number of grains per cob and anthesis silking interval exhibited positive and significant association with 5 ear weight. Hence, direct selection of these characters can be rewarded and should form the selection criteria in breeding programmes. Positive direct effect on the dependent character, 5 ear weight, by the shelled grain weight followed by inter nodal length, days for 50% anthesis and phenols emphasized the need for selection based on these traits.

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