The Pharma Innovation Journal 2021; 10(7): 1062-1067

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(7): 1062-1067

www.thepharmajournal.com
Received: 03-05-2021
Accepted: 09-06-2021

Bal Krishna
Ph.D., Research Scholar, Department of Plant Breeding and Genetics, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Birender Singh
Assistant Professor cum Junior Scientist, Department of Plant Breeding and Genetics, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Shyam Sundar Mandal
Assistant Professor cum Junior Scientist, Department of Plant Breeding and Genetics, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Kumari Rashmi
Assistant Professor cum Junior Scientist, Department of Plant Breeding and Genetics, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Tushar Ranjan
Assistant Professor cum Junior Scientist, Department of Molecular Biology and Genetic Engineering, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Corresponding Author:
Bal Krishna
Ph.D., Research Scholar, Department of Plant Breeding and Genetics, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Association and path coefficient analysis among grain yield and related traits in *kharif* maize (*Zea mays* L.)

Bal Krishna, Birender Singh, Shyam Sundar Mandal, Kumari Rashmi and Tushar Ranjan

Abstract
Thirteen inbred lines, three testers, thirteen nine hybrids, and two checks were tested in an RBD design with three replications at the Irrigation Research Station Farm, Araria, Bihar during the season of *kharif* 2020. The goal was to assess the direct and indirect impacts of characteristics on grain yield in maize and to establish the phenotypic and genotypic connection between traits. Character association studies will aid in assessing the link between the yield and its components in order to improve the selection's effectiveness. In light of this, the current study used twelve quantitative parameters to analyze the correlation coefficient and path analysis among 39 F_1s, 13 inbred, three testers, and two check of maize. Correlation studies indicated that plant height (cm), ear height (cm), ear length (cm), ear diameter (cm), 1000 kernels weight, kernel rows per ear, number of kernels per row showed significant positive association with grain yield (Kg/ha) as well as among themselves at phenotypic and genotypic level. As a result, selecting for any one of these characters would result in improvements in the other characters as well as an increase in grain yield (kg/ha). Path coefficient analysis revealed that the highest positive direct effects on grain yield was exhibited by ear length, ear diameter, kernel rows per ear, kernels per row, 1000 kernels weight, ear height, days to 50% silking. As a result, the current study could aid in the trustworthy selection of parental lines based on the features listed above, as well as the development of high yielding varieties for future breeding programs.

Keywords: *Kharif* maize, agro-morphometric traits, correlation and path analysis

1. Introduction
Maize (*Zea mays* L.) is an important cereal crop in India and holds a key role in worldwide agriculture. Grain yield in maize is a complex characteristic that is influenced by a number of factors. Grain yield, as well as other yield variables that influence grain yield, should be used to choose desirable genotypes. It is critical to understand the relationships between different traits, particularly grain yield, in order to produce promising genotypes with high yield. The correlation analysis is commonly used to determine the relative amount of each independent variable's influence on a dependent variable such as grain yield. Through the application of proper selection indices, understanding of such interrelations between grain yield and its contributing characters can considerably increase the effectiveness of breeding programs (Mohammadia *et al*., 2003) [18]. The purpose of this study was to determine the degree of relationship between grain yield and yield attributes in 39 F1s, 13 inbreds, three testers, and two check of maize for 12 characters.

2. Materials and Methods
The experiment was conducted in Kharif, 2020 at Irrigation Research Station Farm, Araria Bihar (India). The experimental materials consist of 13 lines, three tester, 39 crosses and two checks which were grown in Randomized Block Design (RBD) with three replications. Each plot consisting of two rows of 4 m length spaced at 60 cm row to row and 20 cm plant to plant. All necessary precautions were taken to maintain uniform plant population in each treatment per replication. All the recommended package of practices was followed along with necessary prophylactic plant protection measures to raise a good crop. Observations were recorded on twelve quantitative traits from each replication. The traits which were studied include days to 50% anthesis, days to 50% silking, anthesis silking intervals, days to 75% brown husk, plant height, ear height, ear length, ear diameter, kernel rows per ear, kernels per row, 1000 kernels weight and grain yield. Out of the twelve quantitative characters, days to 50% anthesis, days to 50% silking, anthesis silking intervals and days to 75% brown husk were recorded on plot

basis. Rest of the traits was recorded on the basis of five randomly chosen plants at appropriate stage. The data recorded on different characters were statistically analyzed using software WINDOSTAT version 9.2 developed by Indostat Services Ltd., Hyderabad, India. The phenotypic (rp) and genotypic (rg) correlation coefficients for various characters were calculated by the method suggested by Panse and Sukhatme (1985) [22]. To establish a cause and effect relationship the first partition genotypic and phenotypic correlation coefficient into direct and indirect effects by path analysis as suggested Dewey and Lu (1959) [8] and developed by Wright.

2.1 Genotypic correlation coefficient

Genotypic correlation between traits x and y:

$$Rxy\ (p) = \frac{\sigma_g^2\ (xy)}{\sqrt{\sigma_g^2(x) \times \sigma_g^2(y)}}$$

2.2. Phenotypic correlation coefficient

Phenotypic correlation between traits x and y:

$$Rxy\ (p) = \frac{\sigma_p^2\ (xy)}{\sqrt{\sigma_p^2(x) \times \sigma_p^2(y)}}$$

Where, σ^2g (x y) = genotypic covariance between traits x and y

$\sigma\ ^2$p (x y) = phenotypic covariance between traits x and y

3. Results and Discussion

The relationship between and among traits can be determined using correlation coefficients (both phenotypic and genotypic). In general, genetic and environmental factors are blamed for the correlation between attributes. Phenotypic correlations are caused by both environmental and genetic factors and can be identified by measuring the phenotype, whereas genetic correlations are caused by genetic factors and provide information about the level of additive relationship between two traits, which is critical for effective selection (Bocanski *et al*., 2009) [6]. Because of the strong association between the two characters, a significant positive correlation between them shows that they can be enhanced concurrently in a selection programme (Hayes *et al*., 1955; Eleweanya *et al*., 2015) [9, 11].

Correlation coefficients at genotypic and phenotypic level were worked out among twelve characters in present studied and has been presented in (Tables 1 and 2). Out of twelve characters pairs the magnitude of genotypic correlation coefficient was higher than the corresponding phenotypic correlation coefficients.

In most of the character associations, both genotypic and phenotypic correlation coefficients were significant, and the magnitude of genotypic correlation coefficients for most of the characters was higher than the phenotypic correlation coefficients, except in a few cases. This shows that the environment has a minor impact on the hybrids' overall expression. This also suggests that the attributes evaluated are linked in some way. Such results are in line with the findings of Hefny (2011) [12], Zeeshan *et al*. (2013) [35] and Nataraj *et al*. (2014) [19].

From the perusal of correlation at genotypic level (Table 1) it was evident that Plant height have highly and positive correlation with ear height (0.06). Ear diameter showed strong and positive correlation with ear length (0.90), plant height (0.86) and ear height (0.01). Ear length exhibited highly positive correlation with plant height (0.05) and ear height (0.90). High and Positive correlation of days to 50% silking was observed with anthesis silking intervals (0.81). Days to 75% Brown husk showed highly positive correlation with days to 50% anthesis (0.75), days to 50% silking (0.64) and anthesis silking intervals (0.16). Days to 50% anthesis showed highly positive correlation with days to 50% silking (0.98) and anthesis silking intervals (0.68). Ear length showed highly positive association with ear girth (0.6349), number of kernel rows per ear (0.5120) and number of kernels per row (0.2152) and grain yield (0.6775). 1000 kernels weight exhibited high and positive association with kernels per row (0.24), kernel rows per ear (0.90), ear diameter (0.94), ear length (0.95), planr height (0.98) and ear height (0.93). The near-perfect association between kernel rows per ear, ear diameter, ear length, planr height and ear height with 1000 kernels weight that these characters are controlled by the same gene, indicating that the selection of one character automatically leads to the selection of the other. Kernel rows per ear exhibited highest and positive association with kernels rows per ear (0.26), ear diameter (0.57), ear length (0.59), plant height (0.60), ear height (0.59), days to 75% brown husk (0.58). Kernel rows per ear exhibited highest and positive association with ear diameter (0.88), ear length (0.89), plant height (0.95) and ear height (0.89). The grain yield (kh/ha) ear exhibited highest and positive association with 1000 kernels weight (0.90), kernels per row (0.63), kernel rows per ear (0.87), ear diameter (0.98), ear length (0.91), plant height (0.03) and ear height (0.97). This indicated that by increasing these attributes, could invariably increase grain yield while, exhibited highest and negative association with days to 75% brown husk (-0.65), days to 50% anthesis (-0.89), days to 50% silkig (-0.80) and anthesis silking intervals (-0.32).

From the perusal of correlation at phenotypic level (Table 2) it was evident that Plant height had positive and significant correlation with ear height (0.89). Positive and significant correlation of days to 50% anthesis was observed with days to 50% silking (0.97) and anthesis silking intervals (0.59). Days to 50% silking showed positive and significant correlation with anthesis silking intervals (0.76). Days to 75% brown husk exhibited highly significant positive correlation with days to 50% anthesis (0.13). 1000 kernels weight showed highly significant and positive association with kernels per row (0.32), kernel rows per ear (0.90), ear diameter (0.83), ear length (0.83), plant height (0.78) and ear height (0.84). Kernels per row showed positive and highly significant association with kernel rows per ear (0.34), ear diameter (0.52), ear length (0.53), plant height (0.50) and ear height (0.54). This relationship of ear length, kernel rows per ear and ear diameter with kernels per row, indicating that increase of ear length, kernel rows per ear and ear diameter could result in increased number of kernels in a cob and consequently increase grain yield. Kernel rows per ear showed positive and significant correlation with ear diameter (0.77), ear length (0.78), plant height (0.75) and ear height (0.79). Ear diameter showed positive correlation with ear length (0.90), plant height (0.84) and ear height (0.92). Positive association of grain yield was observed with 1000 kernels weight (0.89), kernels per row (0.65), kernel rows per ear (0.87), ear diameter (0.91), ear length (0.92), plant height (0.85) and ear height (0.92), while negative and significant association showed with days to 50% anthesis (-0.83), days to 50%

silking (-0.74) and anthesis silking intervals (-0.28), indicating decrease in days to 50 per cent anthesis and silking result in early flowering and this could be very helpful in increase in grain yield. The observed positive and significant genotypic and phenotypic correlations of grain yield with these traits indicate that these traits are essential yield components, reflective estimators and selection for them in the respective hybrid populations may lead to a substantial improved grain yield. High correlation of grain yield with plant height is also reported by other researchers (Annapurna *et al*., 1998; Gautam *et al*., 1999). This suggests that genetic factors are responsible for these associations. The positive and highly significant genotypic correlation between traits, suggests that genetic factors are responsible for these associations and these traits could also be considered for selection and improvement for high yielding varieties. The significant positive correlations between yield and other agronomic characters that can improve yield are quite desirable in plant breeding, because it facilitates selection process and gains from selection. Several authors including (Nzuve *et al*., 2014; Adu *et al*., 2016; Beulah *et al*., 2017; Selvaraj and Nagarajan, 2011; Khameneh *et al*., 2012; Begum *et al*., 2016; Kumar *et al*., 2017; Belay, 2018) [1, 2, 5, 14, 15, 27] have observed and reported similar significant positive correlation among days to 50% anthesis and days to 50% silking, plant height (cm) and ear height (cm) and 1000 kernels weight, kernels row per ear and kernels per row.

3.1 Path coefficient analysis

3.1.1 Genotypic path coefficient (Table 3)

The partitioning of the genotypic correlation coefficients into direct and indirect effects through path coefficient analysis are presented in Table 3. Path coefficient analysis at genotypic level revealed that the highest positive direct effects on grain yield (kg/ha) was exhibited by ear length (1.213) followed by days to 50% silking (0.516), kernels per row (0.379), 1000 kernels weight (0.377), plant height (0.027), kernel rows per ear (0.236). These observations are in confirmation with the findings of Netaji (2000); Devi *et al*. (2001) [7]; Venugopal *et al*. (2003) [32]; Kumar *et al*. (2006) [16, 17]; Pavan *et al*. (2011) [23]; Raghu *et al*. (2011) [24]; Ram Reddy *et al*. (2012) [25]; Sudika *et al*. (2015) [30]. Days to 50% silking had indirect positive effect on grain yield via ear diameter (0.275) and ear height (0.641). Days to 50% anthesis showed indirect positive correlation via, ear diameter (0.292), ear height (0.689), days to 50% silking (0.506) on grain yield. Days to 75% brown husk possessed indirect positive effect via kernels per row (0.221), ear diameter (0.210), ear height (0.468) and days to 50% silking (0.333) on grain yield. Anthesis silking intervals had shown indirect positive effect via ear diameter (0.158), ear height (0.354), days to 50% silking (0.420) on grain yield. Ear height possessed indirect positive effect through 1000 kernels weight (0.350), kernels per row (0.222), kernels row per ear (0.209), ear length (1.207), plant height (0.028), days to 75% brown husk (0.017), days to 50% anthesis (0.320) and anthesis silking intervals (0.099). The plant height possessed indirect positive effect via 1000 kernels weight (0.370), kernels per row (0.228), kernels row per ear (0.224), ear length (1.275), days to 75 5 brown husks (0.016), days to 50% anthesis (0.334) and anthesis silking intervals (0.102). Ear length possessed indirect positive effect via 1000 kernels weight (0.359), kernels per row (0.223), kernels rows per ear (0.211), plant height (0.028), days to 75% brown husk (0.021), days to 50% anthesis (0.321) and anthesis silking intervals (0.097). and ear height (0.2958). Ear diameter possessed indirect positive effect on grain yield via 1000 kernels weight (0.353), kernels per row (0.216), kernel rows per ear (0.207), ear length (1.221), plant height (0.028), days to 75% brown husk (0.018), days to 50 5 anthesis (0.327) anthesis silking intervals (0.109). Number of kernel rows per ear possessed indirect positive correlation via 1000 kernels weight (0.337), kernels per row (0.100), ear length (1.082), plant height (0.025), days to 75% brown husk (0.255) and anthesis silking intervals (0.041). Number of kernels per row had indirect positive effect via days to 50% anthesis (0.144), number of kernel rows per ear (0.062)), ear length (0.712), 1000 kernels weight (0.091), plant height (0.016) and anthesis silking intervals (0.012). 1000 kernels weight possessed positive direct effect on grain yield via anthesis silking intervals (0.080), days to 50% anthesis (0.297), days to 75% brown husk (0.023), plant height (0.026), ear length (1.154), kernels row per ear (0.211) and kernels per row (0.092). Similar finding was reported earlier by (Sharma and Kumar, 1987; Kumar *et al*., 2006; Hemavathy *et al*., 2008; Saha and Mukherjee, 1993; Verma *et al*., 2018; Sood and Khajuria, 2006; Bello *et al*., 2009; Gazal *et al*., 2018; Ulaganathan *et al*., 2015) [4, 10, 13, 16, 17, 26, 28, 29, 31, 33] for improving the grain yield of maize.

3.1.2 Phenotypic path coefficient (Table 4)

The positive direct effect on grain yield was showed by ear length (0.150), ear diameter (0.074), kernel rows per ear (0.209), kernels per row (0.289), 1000 kernels weight (0.288), ear height (0.081), days to 50% silking (0.245). Plant height showed positive indirect effect on grain yield through ear length (0.128), kernels per row (0.145), ear diameter (0.062), days to 75% brown husk (0.002), days to 50% anthesis (0.253), ear height (0.071), kernel rows per ear (0.156) and 1000 kernels weight (0.225). Ear height exhibited positive indirect association on grain yield via plant height, kernels per row (0.155), 1000 kernels weight (0.240), kernel rows per ear (0.165), ear length (0.138), ear diameter (0.067), days to 75% brown husk (0.003), days to 50% anthesis (0.281) and anthesis silking intervals (0.009). Days to 50% anthesis showed positive indirect effect on grain yield through plant height (0.022) and days to 50% silking. Days to 75% brown husk was found to have positive indirect effect on grain yield through kernels per row (0.026), plant height (0.003) and days to 50% silking (0.029). Days to 50% silking showed positive indirect effect on grain yield through plant height (0.020). Anthesis silking intervals possessed positive indirect effect on grain yield via Days to 50% silking (0.186) and plant height (0.010). Ear length exhibited positive indirect effect on grain yield through kernels per row (0.153), 1000 kernels weight (0.240), kernels rows per ear (0.162), ear diameter (0.067), ear height (0.074), days to 75% brown husk (0.002), days to 50% anthesis (0.277) and anthesis silking intervals (0.008). Ear diameter showed positive indirect effect on grain yield via ear length (0.135), ear height (0.074), kernels per row (0.151), 1000 kernels weight (0.240), kernel rows per ear (0.162), days to 75% brown husk (0.002), days to 50% anthesis (0.285) and anthesis silking intervals (0.009). Kernel rows per ear showed positive indirect effect on grain yield via 1000 kernels weight (0.260), kernels per row (0.098), ear diameter (0.057), ear length (0.117), ear height (0.064), days to 75% brown husk (0.005), days to 50% anthesis (0.221) and anthesis silking intervals (0.004). Kernels per row exhibited positive indirect effect on grain yield through anthesis silking intervals (0.001), days to 50% anthesis (0.128), ear height (0.043), ear length (0.079), ear diameter (0.038), kernel rows per ear (0.070) and 1000 kernels weight (0.093). 1000 kernels weight exhibited positive indirect effect on grain yield through kernels per row (0.093), kernel row per ear (0.189), ear diameter (0.061), ear height (0.067), ear length (0.125), days to 75% dry husk (0.004), days to 50% anthesis (0.258) and anthesis silking intervals (0.007). Similar findings were reported earlier by Sharma and Kumar, 1987 [28]; Kumar *et al.* (2006) [16, 17]; Hemavathy *et al.* (2008) [13]; Saha and Mukherjee, 1993 [26]; Sood and Khajuria, 2006 [29]; Bello *et al.* (2009) [4]; Verma *et al.* (2017) [15]; Gazal *et al.* (2018) [10]; Ulaganathan *et al.* (2015) [31].

Table 1: Genotypic coefficients of correlation among the twenty quantitative characters.

Traits	1000 - kernels weight (g)	Kernels per row	Kernel rows per ear	Ear diameter (cm)	Ear length (cm)	Plant height (cm)	Ear height (cm)	Days to 75% dry husk	Days to 50% anthesis	Days to 50% silking	Anthesis - silking interval	Grain yield (kg/ha)
1000-kernels weight (g)	1.00	0.24**	0.90**	0.94**	0.95**	0.98**	0.93**	-0.87**	-0.90**	-0.82**	-0.39**	0.90**
Kernels per row		1.00	0.26**	0.57**	0.59**	0.60**	0.59**	0.58**	-0.44**	-0.36**	-0.06	0.63**
Kernel rows per ear			1.00	0.88**	0.89**	0.95**	0.89**	-0.94**	-0.77**	-0.67**	-0.20**	0.87**
Ear diameter (cm)				1.00	0.90**	0.86**	0.01**	-0.71**	-0.99**	-0.93**	-0.54**	0.98**
Ear length (cm)					1.000	0.05**	0.90**	-0.81**	-0.97**	-0.90**	-0.47**	0.91**
Plant height (cm)						1.000	0.06**	-0.61**	-0.91**	-0.94**	-0.50**	0.03**
Ear height (cm)							1.00	-0.66**	-0.97**	-0.90**	-0.49**	0.97**
Days to 75% dry husk								1.00	0.75**	0.64**	0.16*	-0.65**
Days to 50% anthesis									1.00	0.98**	0.68**	-0.89**
Days to 50% silking										1.00	0.81**	-0.80**
Anthesis-silking interval											1.00	-0.32**

* &** Significant at 5% & 1% respective=ely

Table 2: Phenotypic coefficients of correlation among the twelve quantitative characters.

Traits	1000 - kernels weight (g)	Kernels per row	Kernel rows per ear	Ear diameter (cm)	Ear length (cm)	Plant height (cm)	Ear height (cm)	Days to 75% dry husk	Days to 50% anthesis	Days to 50% silking	Anthesis - silking interval	Grain yield (kg/ha)
1000 - kernels weight (g)	1.00	0.32**	0.90**	0.83**	0.83**	0.78**	0.84**	-0.19*	-0.79**	-0.73**	-0.33**	0.89**
Kernels per row		1.00	0.34**	0.52**	0.53**	0.50**	0.54**	0.09	-0.39**	-0.33**	-0.04	0.65**
Kernel rows per ear			1.00	0.77**	0.78**	0.75**	0.79**	-0.20*	-0.68**	-0.59**	-0.17*	0.87**
Ear diameter (cm)				1.00	0.90**	0.84**	0.92**	-0.09	-0.87**	-0.82**	-0.42**	0.91**
Ear length (cm)					1.00	0.85**	0.92**	-0.08	-0.85**	-0.79**	-0.36**	0.92**
Plant height (cm)						1.00	0.89**	-0.11	-0.78**	-0.73**	-0.35**	0.85**
Ear height (cm)							1.00	-0.12	-0.86**	-0.81**	-0.41**	0.92**
Days to 75% dry husk								1.00	0.13**	0.12	0.04	-0.13
Days to 50% anthesis									1.00	0.97**	0.59**	-0.83**
Days to 50% silking										1.00	0.76**	-0.74**
Anthesis-silking interval											1.000	-0.28**

* &** Significant at 5% &1% respectively

Table 3: Genotypic direct effect (diagonal bold) and indirect effect (off diagonal) of the twelve characters on grain yield

Traits	1000 - kernels weight (g)	Kernels per row	Kernel rows per ear	Ear diameter (cm)	Ear length (cm)	Plant height (cm)	Ear height (cm)	Days to 75% dry husk	Days to 50% anthesis	Days to 50% silking	Anthesis - silking interval	Grain yield (kg/ha)
1000 - kernels weight (g)	0.377	0.092	0.211	-0.276	1.154	0.026	-0.660	0.023	0.297	-0.424	0.080	0.899**
Kernels per row	0.091	0.379	0.062	-0.168	0.712	0.016	-0.416	-0.015	0.144	-0.187	0.012	0.630**
Kernel rows per ear	0.337	0.100	0.236	-0.258	1.082	0.025	-0.630	0.027	0.255	-0.345	0.041	0.870**
Ear diameter (cm)	0.353	0.216	0.207	-0.295	1.221	0.028	-0.719	0.018	0.327	-0.482	0.109	0.984**
Ear length (cm)	0.359	0.223	0.211	-0.297	1.213	0.028	-0.708	0.021	0.321	-0.464	0.097	1.002**
Plant height (cm)	0.370	0.228	0.224	-0.311	1.275	0.027	-0.754	0.016	0.334	-0.485	0.102	1.025**
Ear height (cm)	0.350	0.222	0.209	-0.298	1.207	0.028	-0.711	0.017	0.320	-0.465	0.099	0.977**
Days to 75% dry husk	-0.329	0.221	-0.245	0.210	-0.987	-0.016	0.468	-0.026	-0.249	0.333	-0.033	-0.654**
Days to 50% anthesis	-0.339	-0.166	-0.182	0.292	-1.177	-0.027	0.689	-0.019	-0.330	0.506	-0.139	-0.893**
Days to 50% silking	-0.309	-0.138	-0.158	0.275	-1.092	-0.025	0.641	-0.017	-0.324	0.516	-0.166	-0.795**
Anthesis - silking interval	-0.148	-0.022	-0.048	0.158	-0.575	-0.013	0.345	-0.004	-0.226	0.420	-0.204	-0.315**

Residual value = 0.006

Table 4: Phenotypic direct effect depicted diagonal (bold face) indirect effect off-diagonal for the studied traits

Traits	1000 - kernels weight (g)	Kernels per row	Kernel rows per ear	Ear diameter (cm)	Ear length (cm)	Plant height (cm)	Ear height (cm)	Days to 75% dry husk	Days to 50% anthesis	Days to 50% silking	Anthesis - silking interval	Grain yield (kg/ha)
1000 - kernels weight (g)	0.288	0.093	0.189	0.061	0.125	-0.022	0.067	0.004	0.258	-0.179	0.007	0.892**
Kernels per row	0.093	0.289	0.070	0.038	0.079	-0.014	0.043	-0.002	0.128	-0.080	0.001	0.646**
Kernel rows per ear	0.260	0.098	0.209	0.057	0.117	-0.021	0.064	0.005	0.221	-0.145	0.004	0.866**

Ear diameter (cm)	0.240	0.151	0.162	0.074	0.135	-0.024	0.074	0.002	0.285	-0.201	0.009	0.906**
Ear length (cm)	0.240	0.153	0.162	0.067	0.150	-0.024	0.074	0.002	0.277	-0.193	0.008	0.915**
Plant height (cm)	0.225	0.145	0.156	0.062	0.128	-0.028	0.071	0.002	0.253	-0.178	0.008	0.846**
Ear height (cm)	0.240	0.155	0.165	0.067	0.138	-0.025	0.081	0.003	0.281	-0.198	0.009	0.916**
Days to 75% dry husk	-0.054	0.026	-0.041	-0.007	-0.012	0.003	-0.010	-0.023	-0.043	0.029	-0.001	-0.133
Days to 50% anthesis	-0.228	-0.113	-0.142	-0.064	-0.127	0.022	-0.069	-0.003	-0.326	0.238	-0.013	-0.826**
Days to 50% silking	-0.210	-0.095	-0.124	-0.061	-0.118	0.020	-0.065	-0.003	-0.317	0.245	-0.017	-0.744**
Anthesis-silking interval	-0.094	-0.012	-0.035	-0.031	-0.054	0.010	-0.033	-0.001	-0.192	0.186	-0.022	-0.278**

Residual value = 0.1608

4. Conclusion

The most essential characters accounting for cause and effect relationships on grain yield are ear length, ear diameter, kernel rows per ear, kernels per row, 1000 kernels weight, and ear height, according to the results of both correlation and path analysis. As a result, these features have been identified as key yield contributors, and greater attention may be placed on selecting these traits to improve grain yield. As a result, these features should be prioritized when developing selection criteria for increasing grain yield.

5. Acknowledgement

Authors thankful to Dean PGS, Bihar Agricultural University, Sabour, Bhagalpur for their financial support for accomplishing research works. Authors also thankful to publication committee to provide BAU communication number 986/210705 for the manuscript.

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