Study of Correlation Analysis and ~~p~~Path A~~a~~nalysis in Different Genotypes of Pearl millet (*Pennisetum glaucum* L.)

Abstract

The present investigation was carried out as a field experiment for the evaluation of fifty genotypes for various traits and ~~for~~ multivariant analysis. The research aims to study correlation ~~for~~ betweengrain yield and its yield-contributing characteristic. The investigation was carried out atthe Bajara Research Scheme, College of Agriculture, Dhule in 2021. Correlation studies revealed that grain yield per plant showed a significant positive association with ~~the~~ traits such as plant height, productive tillers, panicle girth, panicle length, and test seed weight. While iron and zinc showed a non-significant positive genotypic correlation; negative correlation with days 50 percent flowering, days to maturity, and protein content. Analysis of direct and indirect effects for effective selection.

Keywords: Pearl millet, genotypes, Phenotypic Correlation, Genotypic correlation, path analysis.

Introduction

The concept correlation coefficient was given by Karl Pearson and from related idea it was further introduced by Francis Galton in 1880. It is used to assess the strength and direction of linear relationships between pairs of variables. The study of the action and interactions between significant characters influenced the expression of yield in crop plants. It makes easier to select an appropriate breeding method and parents for crop improvement. The phenotypic and genotypic associations have their own importance in breeding programme. This is owing to the fact that most of the characters are inter related, and a changed in one is likely to influence the other, thus the net benefit received by selecting one may be counterbalanced by a simultaneous change in another. Therefore, correlation is helpful in determining the component characters of a complex trait like yield. The estimated correlation co-efficient between seed yield per plant and all of the features at genotypic and phenotypic levels.Initially Swell Wright (1921) proposed the path co-efficient analysis, which was later developed by Dewey and Lu (1959), allows partitioning of path co-efficient analysis into direct and indirect effects of various characters towards dependent variables and thus helps in assessing the cause-effect relationship and helps to formulate effective selection criterion.

Materials and Methods

The experimental materials used for present research consist of 50 genotypes of pearl millet [*Pennisetum glacum* L.] were received from Bajara Research Scheme, College of Agriculture, Dhule.The field experiment was conducted during the *Kharif* season of 2021 and carried out under randomized block design with two replicaion at the Bajara Research Scheme, College of Agriculture, Dhule, M.S. (India) during *Kharif* 2021.

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Methodology

Estimation of Correlation co-efficient:

Analysis of covariance was carried out by taking two characters at a time. The genotypic and phenotypic co variances were calculated by Singh and Chaudhari (1977) as below.

Environmental covariance ($COVe_{1.2}$) = EMP

Genotypic covariance ($COVg_{1.2}$) = (GMP-EMP)/r

Phenotypic covariance ($COVp_{1.2}$) = ($COVg_{1.2}$) + ($COVe_{1.2}$)

Where,

EMP = Environmental mean product

GMP = Genotypic mean product

To understand the association among the different characters, genotypic and phenotypic correlation co-efficient were worked out by adopting the method described by Johnson *et al*. (1955, b).

Genotypic correlation co-efficient

$$r_{g1.2} = \frac{(COVg_{1.2})}{\sqrt{(\sigma^2 g_1)(\sigma^2 g_2)}} \text{ X 10}$$

Where,

$r_{g1.2}$n = Genotypic correlation between characters 1 and 2

($COVg_{1.2}$) = Genotypic covariance between characters 1 and 2

$\sigma^2 g_1$ and $\sigma^2 g_2$= Genotypic variance of character 1and2 respectively.

Phenotypic correlation co-efficient (r_p):

$$r_{p1.2} = \frac{(COV_{p1.2})}{\sqrt{(\sigma^2 p_1)(\sigma^2 p_2)}} \text{ X 100}$$

Where,

r_p1.2= Phenotypic correlation between characters 1 and 2

(COVp1.2) = Phenotypic covariance between characters 1 and 2

$\sigma^2 p1$ and $\sigma^2 p2$ = Phenotypic variance of character 1 and 2respectively

The significance of the phenotypic and genotypic coefficient were tested by using't' test

$$r_{p1.2} = \frac{\sqrt{n-2}}{1\text{-r }2} \times 100$$

Where,

r = correlation coefficient

n = total number of observations

The calculated't' value was tested with table't' value for respective (n-2) degrees of freedom for significance.

Estimation of Path co-efficient analysis

Correlation co-efficient fails to show an exact picture of the comparative importance of direct and indirect effect of each of the component character. Hence, to establish a cause-and-effect relationship, path co-efficient analysis was suggested by swell wright. The path analysis was carried out and the simple correlation co-efficient (genotypic) were divided into direct and indirect effect by path analysis as suggested by Dewey and Lu (1959).

The characters in addition to the seed yield per plant were selected for path analysis and all possible simple correlation co-efficient them were worked out.

If 'Y' (yield) is the effect and X_1 is the cause, the path co-efficient for the path from causeX_1 to the effect Y is $\sigma X_1 \sigma Y$.

Direct and indirect effects were calculated by genotypic correlations as follows:

Direct effect of X_1 on y = PX_1 Y

Where,

PX_1 = Path co-efficient of X_1 on Y.

Similarly,

Direct effects of other parameters on yield were worked out.

Indirect effect of X_1,X_2 or Y = PX_2 Y × r X_1 X_2

Where,

PX_2Y = Path co-efficient of the component character X_2 on Y.

$r X_1 X_2$ = Genotypic correlation between X_1 and X_2.

Similarly,

Indirect effects in all possible combinations were calculated for all component characters.

The residual effect R was calculated as below,

$R = [1-(PX_1. rX_1Y) - (PX_2. rX_2Y) - ……(PXn. rXnY)]$.

Where,

$PX_1. PX_2,…...PXn$ = Direct effects of respective characters on yield.

$rX_1. rX_2,…. .rXn$ = Correlation co-efficient between respective Characters and yield.

The following set of simultaneous equation were formulated and solved to estimate various direct and indirect effects.

Result and Discission

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Correlation Coefficient

Association between Grain yield per plant and its Components

In the present study, grain yield per plant (Table 1) showed strong significantly positive genotypic association with plant height (0.5915), followed by panicle length (0.5480), 1000 seed weight (0.4890), productive tillers per plant (0.4628), panicle girth (0.3219). Positive non-significant genotypic association with iron (0.0614) and zinc (0.0634). Grain yield per plant has negative association with days to maturity (-0.1727), protein content (-0.0667) and days to 50 percent flowering (-0.0164).

Grain yield per plant (table 2) exhibited strong significant positive phenotypic correlation with plant height (0.5730), panicle length (0.4870), 1000 seed weight (0.4627), productive tillers per plant (0.4389) and panicle girth (0.2908). Nonsignificant association with iron content (0.0686) and zinc content (0.0447). Negative phenotypic association with days to maturity (-0.1102), protein content (-0.0552) and days to 50 percent flowering (-0.0131).

Grain yield per plant demonstrated a substantial positive correlation with plant height, panicle length, 1000 seed weight, productive tillers per plant and panicle girth at both the genotypic and phenotypic levels, as shown in the above results. At both genotypic and phenotypic levels, grain yield per plant demonstrated a non-significant and positive correlation with Iron content and Zinc content. Also, at both genotypic and phenotypic levels, grain yield per plant demonstrated a substantial negative correlation with the days to 50 percent flowering, days to maturity and protein content.

Table 1 Genotypic correlation coefficient for eleven characters in Pearl millet.

Sr. No.	Characters	Days to 50 percent flowering	Days to maturity	Plant height at maturity (cm)	Productive tillers / plant	Panicle girth (cm)	Panicle length (cm)	1000 Seed Weight (g)	Protein content	Iron content (ppm)	Zinc content (ppm)	Grain Yield /plant (g)
1	**Days to 50 percent flowering**	**1.0000**	0.9999**	0.4170**	-0.0590	0.1846	0.4826**	0.0601	-0.1192	-0.5202**	-0.1280	-0.0164
2	**Days to maturity**		**1.0000**	0.2175*	-0.1095	0.0635	0.3574**	-0.0180	-0.1932	-0.5786***	-0.1958*	-0.1727
3	**Plant height at maturity (cm)**			**1.0000**	0.3279**	0.4437**	0.8445**	0.5099**	0.0628	-0.1215	-0.0258	0.5915**
4	**Productive tillers / plant**				**1.0000**	0.4298**	0.4104**	0.3144**	-0.1929	0.3947**	0.3135**	0.4628**
5	**Panicle girth (cm)**					**1.0000**	0.5617**	0.1043	0.0941	0.2316*	0.4161**	0.3219**
6	**Panicle length (cm)**						**1.0000**	0.3920**	0.0774	-0.0837	0.1142	0.5480**
7	**1000 Seed Weight (g)**							**1.0000**	0.2382*	0.2944**	0.2174*	0.4890**
8	**Protein content (%)**								**1.0000**	0.3286**	0.2066*	-0.0667
9	**Iron content (ppm)**									**1.0000**	0.6130**	0.0614
10	**Zinc content (ppm)**										**1.0000**	0.0634

*, **Indicates significance at 5 % and 1% level respectively.

Table 2: Phenotypic correlation coefficient for eleven characters in Pearl millet.

Sr. No.	Characters	Days to 50 percent flowering	Days to maturity	Plant height at maturity (cm)	Productive tillers / plant	Panicle girth (cm)	Panicle length (cm)	1000 Seed Weight (g)	Protein content	Iron content (ppm)	Zinc content (ppm)	Grain Yield /plant (g)
1	**Days to 50 percent flowering**	**1.0000**	0.8099 **	0.3435**	-0.0455	0.1730	0.3539 **	0.0386	-0.0760	-0.4236 ***	-0.1127	-0.0131
2	**Days to maturity**		**1.0000**	0.1688	-0.0734	0.0810	0.2098 *	-0.0309	-0.1303	-0.3839 **	-0.1154	-0.1102
3	**Plant height at maturity (cm)**			**1.0000**	0.3144 **	0.4097**	0.7529 **	0.4962 **	0.0377	-0.1126	-0.0197	0.5730**
4	**Productive tillers / plant**				**1.0000**	0.3859 **	0.3401 **	0.2987 **	-0.1800	0.3555 **	0.2763 **	0.4389**
5	**Panicle girth (cm)**					**1.0000**	0.5100 **	0.0947	0.0668	0.2087 *	0.3619 **	0.2908**
6	**Panicle length (cm)**						**1.0000**	0.3473**	0.0623	-0.0730	0.0811	0.4870**
7	**1000 Seed Weight (g)**							**1.0000**	0.2311*	0.2843 **	0.2181 *	0.4627**
8	**Protein content (%)**								**1.0000**	0.2934 **	0.1988 *	-0.0552
9	**Iron content (ppm)**									**1.0000**	0.5781 **	0.0686
10	**Zinc content (ppm)**										**1.0000**	0.0447

*, **Indicates significance at 5% and 1% level respectively.↑

Association between Component Characters

1.Days to 50% flowering

Days to 50 percent flowering had a substantial positive correlation with days to maturity, panicle girth, plant height, test weight and panicle length at both genotypic and phenotypic levels, as shown by the above results. At both genotypic and phenotypic levels, days 50 percent to flowering had a negative correlation with the number of productive tillers per plant, protein, iron and zinc contents.

2.Days to Maturity

Days to maturity had a substantial positive correlation with days 50 percent to flowering, plant height and panicle girth as shown in the above results. At both the genotypic and phenotypic levels, days to maturity had a non-significant and negative correlation with the number of productive tillers per plant, test seed weight, protein and zinc contents. At both genotypic and phenotypic levels, indicated a significant and negative correlation with iron content.

3. Plant height

Plant height had a exhibited positive correlation with days to flowering, days to maturity, productive tillers, length of panicle, panicle girth, 1000 seed weight, and protein content at both genotypic and phenotypic levels, according to the above results. At both the genotypic and phenotypic levels, plant height demonstrated a substantial non-significant negative correlation with the Iron and Zinc content.

4. Number of productive tillers per plant

At both genotypic and phenotypic levels, the number of productive tillers per plant had a non-significant and negative correlation with days to flowering, days to maturity and protein content. At both genotypic and phenotypic levels, it demonstrated a significant and positive correlation with plant height, panicle girth, panicle length, test seed weight, iron and zinc content.

5. Panicle girth

Panicle girth had a non-significant positive connection with days to maturity, days to flowering, test weight and protein at genotypic and phenotypic levels, according to the aforementioned findings. At both the genotypic and phenotypic levels, panicle girth exhibited a significant positive correlation with the plant height, number of productive tillers per plant, plant length, iron and zinc content.

6. Panicle length

At both genotypic and phenotypic levels, it had a significant and positive correlation with days to 50 % flowering, days to maturity, plant height, productive tillers, panicle girth, panicle length, Iron and Zinc content as seen in the above results. The non-significant and positive correlation with test seed weight and protein content at both genotypic and phenotypic levels.

7. 1000 seed weight

The 1000 seed weight demonstrated a substantial positive correlation with days to 50% flowering, plant height, productive tillers, panicle girth, panicle length, protein, iron content and zinc content at both genotypic and phenotypic levels, as shown in the above results. At both the genotypic and phenotypic levels, days to maturity demonstrated a substantial negative correlation with grain yield.

8.Protein content

protein content had significant positive correlation test seed weight, iron and zinc content at both genotypic as well as phenotypic level. At both the genotypic and phenotypic levels, non-significant positive correlation with plant height, panicle girth and panicle length. At both the genotypic and phenotypic levels, non-significant negative correlation with days to 50 percent flowering, days to maturity and number of productive tillers.

9. Iron content

iron content had significant positive correlation with productive tillers, panicle girth, test seed weight, protein and zinc content at both genotypic as well as phenotypic level. At both the genotypic and phenotypic levels, iron content exhibited a substantial negative correlation with days to 50 % flowering, days to maturity. At both the genotypic and phenotypic levels, plant height and panicle length had a non-significant and negative correlation with iron content.

10. Zinc content

zinc content had significant positive correlation with productive tillers, panicle girth, test seed weight, protein and iron content at genotypic and phenotypic levels. At both the genotypic and phenotypic levels, zinc content had a substantial negative correlation with days to maturity. At both genotypic and phenotypic levels, zinc content demonstrated a non-significant and negative correlation with days to 50 flowering and plant height.

Path Analysis:

Grain yield per plant was considered as the resultant (dependent) variable while the remaining eleven yield contributing characters as the causal (independent) variables.

Direct effect of yield components on grain yield per plant:

Out of ten yield components in genotypic path coefficient studies, plant height (0.2704), panicle length (0.2877), 1000 seed weight (0.2958) and productive tillers per plant (0.1748) had a considerable direct effect on grain yield per plant. These characters also demonstrate significant and positive correlation with grain yield. While, meagre direct effect on grain yield was exhibited by panicle girth (0.0862), and zinc content (0.0052). Actually, zinc content has a non-significant and positive correlation with grain yield per plant. Days to maturity (0.0420) had also shown positive direct effect on grain yield but it was negatively correlated (-0.1727) with grain yield.

Days to 50 %flowering (-0.4789) and Iron content (-0.2464) and protein content (-0.1199) these characters are recorded negative direct effect on grain yield.

Plant height (0.3101), productive tillers per plant (0.2116), 1000 seed weight (0.2527) and panicle length (0.1357) had the most significant correlation and positive direct effect on plant grain yield in terms of phenotypic path co-efficient. Panicle girth (0.0679) had shown meagre direct effect and significant correlation with grain yield. The Days to 50 % flowering (-0.1398), days to maturity (-0.1133), protein content (-0.0873), Iron content (-0.0922) and zinc content (-0.0566) had a direct negative effect on plant grain yield at phenotypic path coefficient.

Plant height, number of productive tillers per plant, panicle girth, panicle length,1000 seed weight, all had a positive direct effect on grain yield at both the genotypic and phenotypic levels, as shown by the above results. At both the genotypic and phenotypic levels, days to 50 % flowering, protein, iron content showed a negative direct effect on grain yield per plant. Days to maturity and zinc content had a positive direct effect on grain yield at the genotypic level, and days to maturity and zinc content had a negative direct effect on grain yield at the phenotypic level**.**

Indirect effect of yield components on grain yield per plant:

1. Days 50 % to flowering:

At the genotypic level, the character, days to 50%flowering had a non-significant and negative correlation with the grain yield per plant (-0.0164) and contributed through its indirect effect via., positively with Iron content (0.2491), zinc content (0.0613) protein content (0.0571) and productive tillers per plant (0.0283), while it was negatively via., 1000 seed weight (-0.0288), panicle girth (-0.0884), panicle length (-0.2311), plant height (-0.1997) and days to maturity (-0.5220).

At the phenotypic level, the character, days to 50% flowering had a non-significant and negative correlation with grain yield per plant (-0.0131) and contributed through its indirect effect via, positively with Iron (0.0592), Zinc (0.0158), protein (0.0106), and productive tillers per plant (0.0064). While, negatively via., 1000 seed weight (-0.0054), panicle girth (-0.0242), plant height (-0.0480), panicle length (-0.0495) and days to maturity (-0.1132),

Days to 50% flowering had a non-significant and negative correlation with grain yield per plant and contributed through its indirect effect via positively with productive tillers per plant, protein content, Iron content, and zinc content and negatively via., days to maturity, plant height, panicle girth, panicle length, test seed weight.

2. Days to maturity:

Non-significant and negative genotypic correlation was showed by days to maturity with grain yield per plant (-0.1727) and it contributed through its indirect effect via., positively with days to 50 % flowering (0.0457) plant height (0.0091), panicle girth (0.0027), panicle length(0.0150), negatively via., 1000 seed weight (-0.0008),productive tillers per plant(-0.0046), protein content (-0.0081), zinc content (-0.0082) and iron content (-0.0243).

Non-significant and negative phenotypic correlation was showed by days to maturity with grain yield per plant (-0.1102) and it contributed through its indirect effect via., positively with Iron content (0.0435), protein content (0.0148), and zinc content (0.0131) productive tillers per plant (0.0083) and 1000 seed weight (0.0035). Negatively its indirect effect via., panicle girth (-0.0092),plant height (-0.0191), panicle length (-0.0238)and days to 50 % flowering (-0.0918).

The results were conclude that days to maturity was negative correlation with grain yield per plant and contributed through its indirect effect via positively with days to 50%

flowering, plant height, panicle girth, panicle length and negatively with productive tillers per plant, 1000 seed weight, protein iron content, zinc content at genotypic level Contrary result observed that days to maturity was negative correlation with grain yield per plant and contributed through its indirect effect via positively with productive tillers per plant, 1000 seed weight, protein content, Iron content, zinc content and negatively with days to 50% flowering, plant height, panicle girth, panicle length at phenotypic level.

2.Plant height:

Significant and positive genotypic correlation was exhibited by plant height with grain yield per plant (0.5915) and contributed through its indirect effect via., positively with panicle length (0.2283), 1000 seed weight (0.1379), panicle girth (0.1200), days to 50 % flowering (0.1128), productive tillers per plant (0.0887), Days to maturity (0.0588), protein (0.0170) and negatively with iron content (-0.0329) and zinc content (-0.0070) content.

Significant and positive phenotypic correlation was exhibited by plant height with grain yield per plant (0.5730) and contributed through its indirect effect via., positively with 1000 seed weight (0.1539), panicle length (0.2335), panicle girth (0.1270), days to 50 % flowering (0.1065), productive tillers per plant (0.0975), days to maturity (0.0523), protein content (0.0117) and negatively with Iron content (-0.0349) and zinc content (-0.0061) content.

Plant height had positive and significant correlation with grain yield indirect effect via positively with days to 50% flowering, panicle girth, panicle length, days to maturity, productive tillers per plant, 1000 seed weight, protein content and negatively with iron content and zinc content at both genotypic and phenotypic level.

4. Productive tillers per plant:

The productive tillers per plant exhibited significant and positive genotypic correlation with grain yield per plant (0.4628) and contributed through its indirect effects via., positively with panicle girth (0.0751), panicle length (0.0717), Iron content (0.0690), plant height (0.0573), zinc content (0.0548), 1000 seed weight (0.0550) and negatively with days to 50% flowering (-0.0103), days to maturity (-0.0191), and protein (-0.0337) at genotypic level.

The productive tillers per plant exhibited significant and positive phenotypic correlation with grain yield per plant (0.4389) and contributed through its indirect effects via., positively with panicle girth (0.0817), Iron content (0.0752), panicle length (0.0720), plant height (0.0

665) 1000 seed weight (0.0632) and zinc content (0.0585), while negatively with days to flowering (-.0096),days to maturity (-0.0155) and protein content (-0.0381).

Productive tillers per plant had positive and significant correlation with grain yield. It has indirect effect via positively with Plant height, panicle girth, panicle length, 1000 seed weight,iron content and zinc content and negatively with days to 50% flowering, days to maturity and protein content at both genotypic and phenotypic level.

5. Panicle girth:

Panicle girth had significant positive genotypic correlation with grain yield per plant (0.3219) and contributed through its indirect effect via., positively with panicle length (0.0484), plant height (0.0382), productive tillers per plant (0.0371), zinc content (0.0359), Iron content (0.0200), days to 50% flowering (0.0159), 1000 seed weight (0.0090), protein (0.0081) and days to maturity (0.0055).

Panicle girth had significant positive phenotypic correlation with grain yield per plant (0.2908) and contributed through its indirect effect via., positively with panicle length (0.0346), plant height (0.0.0278), productive tillers per plant (0.0262), zinc content (0.0246), Iron content (0.0142), days to 50% flowering (0.0117), 1000 seed weight (0.0064), days to maturity (0.0055) and protein (0.0045).

Panicle girth had significant positive phenotypic correlation with grain yield per plant indirect effect via positively with all the characters at both phenotypic and genotypic level.

6. Panicle length:

Panicle length exhibited significant and positive genotypic correlation with grain yield per plant (0.5480) and contributed through its indirect effect via., positively with plant height (0.2429), panicle girth (0.1616), days to 50 percent flowering (0.1388), productive tillers per plant (0.1181), 1000 seed weight (0.1128), days to maturity (0.1028), Zinc content (0.0329) and protein content (0.0223) and negatively with Iron content (-0.0241).

Panicle length exhibited significant and positive phenotypic correlation with grain yield per plant (0.4870) and contributed through its indirect effect via., positively with plant height (0.1022), panicle girth (0.0692), days to 50 percent flowering (0.0480), 1000seed weight (0.0471), productive tillers per plant (0.0462), days to maturity (0.0285) Zinc content (0.0110), protein content (0.0085) and negatively with Iron content (-0.0099).

Panicle length exhibited significant and positive phenotypic correlation with grain yield per plant and contributed through its indirect effect via., positively with plant height, panicle girth, days to 50 percent flowering, 1000seed weight, productive tillers per plant, days to maturity, Zinc content and protein while negatively with Iron content at both genotypic and phenotypic level.

7. 1000 seed weight:

1000 weight exhibited the significant and positive genotypic correlation with grain yield per plant (0.4809) and contributed through its indirect effect via., positively with plant height (0.1508), panicle length (0.1160), productive tillers per plant (0.0930), Iron content (0.0871), protein content (0.0705), zinc content (0.0643), panicle girth (0.0309), and days to 50% flowering (0.0178) and negatively with days to maturity (-0.0053).

1000 weight exhibited the significant and positive phenotypic correlation with grain yield per plant (0.4627) and contributed through its indirect effect via., positively with plant height (0.1254), panicle length (0.0877), productive tillers per plant (0.0755), Iron content (0.0718), protein content (0.0584), zinc content (0.0551), panicle girth (0.0239), and days to 50% flowering (0.0097) and negatively with days to maturity (-0.0078).

The significant and positive genotypic correlation of 1000 weight exhibited with grain yield per plant and contributed through its indirect effect via., positively with plant height, panicle length, productive tillers per plant, iron content, protein content, zinc content, panicle girth, and days to 50% flowering and negatively with days to maturity at both genotypes and phenotypes.

4.4.2.8 Protein Content:

Protein exhibited the was non-significant and negative genotypic correlation with grain yield per plant (-0.0667) and contributed through its indirect effect via., positively with days to maturity (0.0232), productive tillers per plant (0.0231), days to 50 % flowering (0.0143), and negative with plant height (-0.0075), panicle length (-0.0093), panicle girth (-0.0113), zinc content (-0.0248), 1000 seed weight (-0.0286), and iron content (-0.0394).

Protein exhibited the non-significant and negative phenotypic correlation with grain yield per plant (-0.0552) and contributed through its indirect effect via., positively with days to maturity (0.0114), productive tillers per plant (0.0157), days to 50 % flowering (0.066), and negative with plant height (-0.0033), panicle length (-0.0054), panicle girth (-0.0058), zinc content (-0.0174) 1000 seed weight (-0.0202), and iron content (-0.0256).

The non-significant and negative genotypic correlation of protein content with grain yield per plant and contributed through its indirect effect via., positively with days to maturity, productive tillers per plant, days to 50 % flowering, and negative with plant height, panicle length, panicle girth, zinc content, 1000 seed weight, and iron content.

9. Iron content:

The non-significant and positive genotypic correlation with grain yield per plant (0.0614) exhibited by iron content and contributed through its indirect effect via., positively with days to maturity (0.1426), days to 50 % flowering (0.1282), plant height(0.0299), panicle length(0.0206) and negatively with protein content (-0.0810), panicle girth (-0.0571), 1000 seed weight (-0.0725), productive tillers per plant (-0.0972) and zinc content (-0.1510).

The non-significant and positive phenotypic correlation with grain yield per plant (0.0686) exhibited by iron content and contributed through its indirect effect via., positively with days to maturity (0.0354), days to 50 % flowering (0.0390), plant height(0.0104), panicle length(0.0067) and negatively with protein content (-0.0270), panicle girth (-0.0192), 1000 seed weight (-0.0262) productive tillers per plant (-0.0328) and zinc content (-0.0533).

The non-significant and negative phenotypic correlation with grain yield per plant exhibited by iron content and contributed through its indirect effect via., positively with

days to 50 percent flowering, days to maturity, plant height, panicle length, and negatively with productive tillers per plant, panicle girth, 1000 seed weight, protein and zinc content at both phenotypic and genotypic level.

10. Zinc content:

Non-significant and positive genotypic correlation with grain yield per plant (0.0634) was exhibited by zinc content and contributed through its indirect effects via., positively with Iron content (0.0032), panicle girth (0.0022), productive tiller per plant (0.0016), 1000 seed weight (0.0011), protein (0.0011), panicle length (0.0006) and negatively with plant height (-0.0001), days to 50 percent flowering (-0.0007), days to maturity (-0.0010).

Non-significant and positive genotypic correlation with grain yield per plant (0.0447) was exhibited by zinc content and contributed through its indirect effects via., positively with days to days to maturity (0.0065), days to 50 flowering (0.0064), plant height (0.0011) and negatively with panicle length (-0.0046), Protein content (-0.0112), 1000 seed weight (-0.0123), productive tillers per plant (-0.0156), panicle girth (-0.0205) and Iron content (-0.0327).

Zinc content has non-significant and positive genotypic correlation with grain yield per plant and contributed through its indirect effects via., negatively with days to 50% flowering, days to maturity and plant height at genotypic level and positively with days to 50% flowering, days to maturity and plant height at phenotypic level. While, zinc had indirect effects via., positively with Iron content, panicle girth, productive tiller per plant, 1000 seed weight, protein, panicle length at genotypic level and negatively zinc had indirect effects via., with Iron content, panicle girth, productive tiller per plant, 1000 seed weight, protein, panicle length at phenotypic level.

Table 3: Genotypic path co-efficient for eleven characters in Pearl millet.

Sr. No.	Characters	**Days to 50 percent flowering**	**Days to maturity**	**Plant height at maturity (cm)**	**Productive tillers per plant**	**Panicle girth (cm)**	**Panicle length (cm)**	**1000 Seed Weight (g)**	**Protein content (%)**	**Iron content (ppm)**	**Zinc content (ppm)**	**Grain yield per plant (g)**
1	Days to 50 percent flowering	**-0.4789**	-0.5220	-0.1997	0.0283	-0.0884	-0.2311	-0.0288	0.0571	0.2491	0.0613	-0.0164
2	Days to maturity	0.0457	**0.0420**	0.0091	-0.0046	0.0027	0.0150	-0.0008	-0.0081	-0.0243	-0.0082	-0.1727
3	Plant height at maturity (cm)	0.1128	0.0588	**0.2704**	0.0887	0.1200	0.2283	0.1379	0.0170	-0.0329	-0.0070	0.5915**
4	Productive tillers per plant	-0.0103	-0.0191	0.0573	**0.1748**	0.0751	0.0717	0.0550	-0.0337	0.0690	0.0548	0.4628**
5	Panicle girth (cm)	0.0159	0.0055	0.0382	0.0371	**0.0862**	0.0484	0.0090	0.0081	0.0200	0.0359	0.3219**
6	Panicle length (cm)	0.1388	0.1028	0.2429	0.1181	0.1616	**0.2877**	0.1128	0.0223	-0.0241	0.0329	0.5480**
7	1000 Seed Weight (g)	0.0178	-0.0053	0.1508	0.0930	0.0309	0.1160	**0.2958**	0.0705	0.0871	0.0643	0.4809**
8	Protein content (%)	0.0143	0.0232	-0.0075	0.0231	-0.0113	-0.0093	-0.0286	**-0.1199**	-0.0394	-0.0248	-0.0667
9	Iron content (ppm)	0.1282	0.1426	0.0299	-0.0972	-0.0571	0.0206	-0.0725	-0.0810	**-0.2464**	-0.1510	0.0614
10	Zinc content (ppm)	-0.0007	-0.0010	-0.0001	0.0016	0.0022	0.0006	0.0011	0.0011	0.0032	**0.0052**	**0.0634**

R Square= 0.5622

Residual effect = (0.6616)

*, ** Indicates significance at 5 % and 1% level respectively.

Bold values indicated direct effect

Table 4.: Phenotypic path coefficient for eleven characters in Pearl millet.

Sr. No.	Characters	Days to 50 percent flowering	Days to maturity	Plant height at maturity (cm)	Productive tillers per plant	Panicle girth (cm)	Panicle length (cm)	1000 Seed Weight (g)	Protein content (%)	Iron content (ppm)	Zinc content (ppm)	Grain yield per plant (g)
1	Days to 50 percent flowering	**-0.1398**	-0.1132	-0.0480	0.0064	-0.0242	-0.0495	-0.0054	0.0106	0.0592	0.0158	-0.0131
2	Days to maturity	-0.0918	**-0.1133**	-0.0191	0.0083	-0.0092	-0.0238	0.0035	0.0148	0.0435	0.0131	-0.1102
3	Plant height at maturity (cm)	0.1065	0.0523	**0.3101**	0.0975	0.1270	0.2335	0.1539	0.0117	-0.0349	-0.0061	0.5730**
4	Productive tillers per plant	-0.0096	-0.0155	0.0665	**0.2116**	0.0817	0.0720	0.0632	-0.0381	0.0752	0.0585	-0.4389**
5	Panicle girth (cm)	0.0117	0.0055	0.0278	0.0262	**0.0679**	0.0346	0.0064	0.0045	0.0142	0.0246	0.2908**
6	Panicle length (cm)	0.0480	0.0285	0.1022	0.0462	0.0692	**0.1357**	0.0471	0.0085	-0.0099	0.0110	0.4870**
7	1000 Seed Weight (g)	0.0097	-0.0078	0.1254	0.0755	0.0239	0.0877	**0.2527**	0.0584	0.0718	0.0551	0.4627**
8	Protein content (%)	0.0066	0.0114	-0.0033	0.0157	-0.0058	-0.0054	-0.0202	**-0.0873**	-0.0256	-0.0174	-0.0552
9	Iron content (ppm)	0.0390	0.0354	0.0104	-0.0328	-0.0192	0.0067	-0.0262	-0.0270	**-0.0922**	-0.0533	0.0686
10	Zinc content (ppm)	0.0064	0.0065	0.0011	-0.0156	-0.0205	-0.0046	-0.0123	-0.0112	-0.0327	**-0.0566**	**0.0447**

Residual effect = (0.7186)

R squre =0.4836

Bold values indicated direct effect

*, ** Indicates significance at 5% and 1% level respectively.

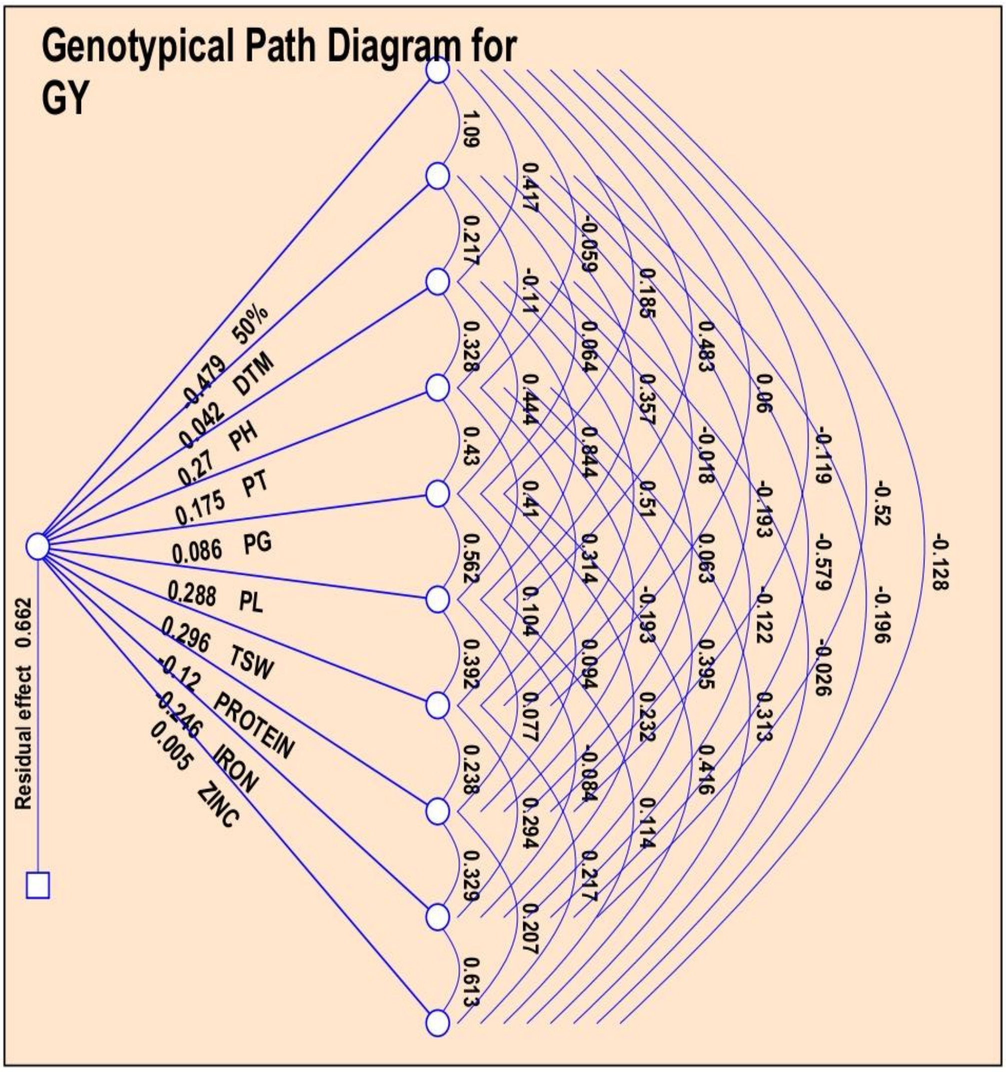

Fig 1- Genotypic path diagram for seed yield per plant

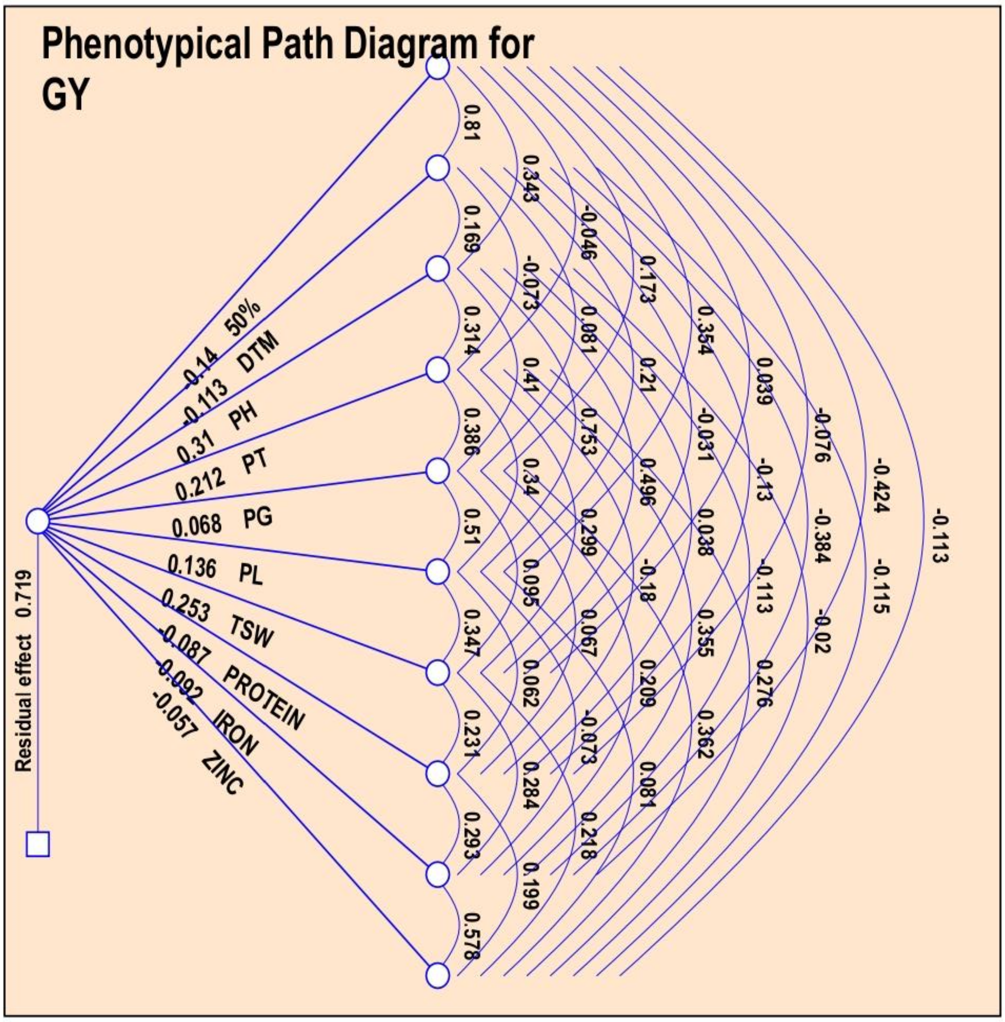

Fig 2- Phenotypic path diagram for seed yield per plant

Conclusion

Correlation studies at both genotypic and phenotypic levels were worked out to resolve the direction and magnitude of association among the characters. Correlation study revealed that grain yield per plant showed significant positive association with the traits such as plant height, productive tillers, panicle girth, panicle length, test seed weight. While iron and zinc showed non- significant positive genotypic correlation; negative correlation with days 50 percent flowering, days to maturity, protein content.

The high magnitudal direct effect was observed for the characters plant height, productive tillers per plant, panicle girth, panicle length and 1000 seed weight as well as the highly significant correlation in the desired direction towards grain yield, indicates direct selection based on these characters would help in selecting the high grain yielding genotypes.

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