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MB Akhare
PG Scholar, Department of Agricultural Botany, College of Agriculture, Badnapur. VNMKV Parbhani, Maharashtra, India

AB Bagade
Assistant Professor (Breeding), National Agricultural Research Project, Chhatrapati, Sambhajinagar, Maharashtra, India

SB Pawar
Associate Director (Research), National Agricultural Research Project, Chhatrapati, Sambhajinagar, Maharashtra, India

DR Kahate
M.Sc Agri (GPB), Department of Agricultural Botany, College of Agriculture, Badnapur, Maharashtra, India

MD Patil
PG Scholar, Department of Agricultural Botany, College of Agriculture, Badnapur, Maharashtra, India

Corresponding Author:
MB Akhare
PG Scholar, Department of Agricultural Botany, College of Agriculture, Badnapur. VNMKV Parbhani, Maharashtra, India

Character association studies for grain yield and its components in pearl millet [*Pennisetum glaucum* (L.) R. Br] germplasm

MB Akhare, AB Bagade, SB Pawar, DR Kahate and MD Patil

Abstract
An experiment entitled "Character association studies for grain yield and its components in pearl millet [*Pennisetum glaucum* (L.) R. Br.] germplasm" was carried out during *Kharif* 2022-23 at the research farm of National Agricultural Research Project, Chhatrapati Sambhajinagar. The experiment was laid out in Randomized Block Design (RBD) with 32 genotypes and two replications to estimate the association between grain yield and yield contributing characters. In this experiment, genotypic correlation coefficients were higher than the phenotypic correlation coefficients. According to correlation results, grain yield per plant was significantly and positively correlated with plant height, panicle length, no. of productive tillers per plant, panicle girth, 1000 grain weight, green fodder yield per plant, harvest index, grain yield per plot and green fodder yield per plant at both genotypic and phenotypic levels. Days to 50% flowering recorded positive and significant correlation with days to maturity at both levels.

Keywords: Correlation, genotypic, phenotypic

Introduction
Pearl millet [*Pennisetum glaucum* (L.) R. Br] is a versatile and resilient cereal crop, holds a significant place in the world of agriculture due to its adaptability to arid and semi-arid environments. Belonging to the *Poaceae* family, this warm-season crop is characterized by its tall stature, robust stalks, and distinctive pearl-shaped seeds, which lend the plant its name. Originating from Africa, pearl millet has become a staple food in many regions across the globe, especially in arid and drought-prone areas where it thrives in conditions that challenge the growth of other crops. Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is a short-day, warm-weather crop and exhibits even greater drought resistance than sorghum. There is no other cereal that thrives as effectively in hot, arid regions. It is cultivated in regions characterized by prolonged dry periods, such as Sudan and the plains of Rajasthan in India.
The primary states for pearl millet cultivation in India include Rajasthan, Maharashtra, Uttar Pradesh, Gujarat, and Haryana. These states collectively account for 90% of the total production in the country. Pearl millet is not expensive like pearl but definitely it has pearl like quality which is beneficial to the body. 100 grams of bajra contains- energy (360 calories), moisture (12g), protein (12g), fat (5g), mineral (2g), fiber (1g), carbohydrate (67g), calcium (42 mg), phosphorus (242 mg) and iron (8 mg). It offers gluten-free grains with high and better protein in terms of quality and quantity making it ideal for people with gluten allergy.
Estimation of correlation between yield and other traits are useful in selecting desired plant traits for designing an effective breeding procedure. Correlation coefficient measures the degree of association and also the genetic or non-genetic relationship between two or more traits which forms the basis for selection. It estimates effect of independent yield attributes upon the dependent variable economic yield.

Materials and Methods
The present investigation was conducted during *Kharif* season of 2022 at the National Agricultural Research Project, Paithan Road, Chhatrapati Sambhajinagar VNMKV Parbhani Maharashtra. The experimental material consisted of 32 diverse genotypes of pearl mill*et al*ong with two checks ABPC 4-3 and AIMP-92901. The evaluation of different genotypes was performed in two replications using Randomized Block Design (RBD). Each genotype was sown in a two rows of 4 m length with spacing of 45 cm between rows and 15 cm between plants.

The recommended agronomical and plant protection practices were ensure successful crop cultivation. Observations were implemented to recorded for five randomly selected plants from each replication for 14 characters including days to 50% flowering, days to maturity, plant height (cm), no. of productive tillers per plant, panicle length (cm), panicle girth (cm), 1000 - grain weight (g), grain yield per plant (g), grain yield per plot (kg/plot), green fodder yield per plant (g), green fodder yield per plot (kg/plot), harvest index (%), Fe content (ppm), Zn content (ppm).Appropriate variances and co-variances were used for calculate phenotypic and genotypic correlation coefficients (Johnson *et al.*, 1955) [4].

Results and Discussion

Genotypic correlation gives an idea about the extent to which the two characters are under the control of same set of genes or have same physiological basis for their expressions. If genotypic correlation is positive, the selection practiced for the improvement in one character will automatically result in the improvement for others and *vice-versa*. The knowledge of relationship between grain yield and its components is essential and selection for one component character may bring about a simultaneous change in the other. Therefore, for a rational approach to improve yield, it may be useful to collect information on character association.

Although genotypic correlation coefficients were generally higher than their corresponding phenotypic correlation coefficients for most of the characters, while in some cases phenotypic correlation coefficients were higher than the genotypic, these may be attributed to the environmental influence. The values of genotypical correlation shown in Table. 1 and Fig. 1. Phenotypical correlation coefficients shown in Table. 2 and Fig.2.

Grain yield per plant recorded significant and positive association with plant height (G = 0.793, P = 0.705), no of productive tillers per plant (G = 0.984, P = 0.966), panicle length (G = 0.812, P = 0.938), panicle girth (G = 0.988, P = 0.931), 1000 grain weight (G = 0.983, P = 0.970), green fodder yield per plant(G = 0.785, P = 0.731), harvest index (G = 0.644, P = 0.644), grain yield per plot (G = 0.712, P = 0.999), green fodder yield per plot (G = 0.789, P = 0.730) at genotypic and phenotypic levels, respectively. There was significant but negative, correlation with Fe content (G = -0.379, P = -0.339), Zn content (G = -0.721, P = -0.519) at genotypic and phenotypic levels. Grain yield per plant recorded non-significant and positive association with days to 50% flowering (G = 0.119, P = 0.093), days to maturity (G = 0.109, P = 0.078) at genotypic and phenotypic levels, respectively.

The character days to 50 per cent flowering had significant and positive association with days to maturity (G = 0.986, P = 0.985) at genotypic and phenotypic levels, respectively. There was also recorded positive significant correlation with harvest index (G=0.253) at genotypic level and positive non-significant (P = 0.100) at phenotypic level.

The character days to maturity had positive non-significant positive correlation with plant height (G = 0.2141, P = 0.0516), no of productive tillers per plant (G = 0.1535 P = 0.0881), panicle girth (G = 0.2158, P = 0.1308), 1000 grain weight (G = 0.0980, P = 0.0619), green fodder yield per plant (G = 0.1224, P = 0.0099), harvest index (G= 0.1739, P= 0.0642), grain yield per plot (G = 0.099, P = 0.077), green fodder yield per plot (G = 0.1131, P = 0.0150) at both levels.

The character plant height had positive significant correlation with no. of productive tillers per plant (G = 0.806, P = 0.731), panicle length (G = 0.644, P = 0.615), panicle girth (G = 0.780, P = 0.703) and 1000 grain weight (G = 0.846, P =0.716), green fodder yield per plant (G= 0.888, P=0.908), grain yield per plot (G=0.797, P=0.710), green fodder yield per plot (G=0.755, P=0.908) at genotypic and phenotypic levels. There was positive and non significant correlation with harvest index (G =0.0128, P =0.1539) at both levels.

The character no. of productive tiller per plant had positive significant correlation with panicle length (G = 0.843, P = 0.881), panicle girth (G = 0.834, P = 0.918), 1000 grain weight (G= 0.964, P = 0.938), green fodder yield per plant (G= 0.836, P= 0.758), harvest index (0.627 P = 0.552), grain yield per plot (G= 0.985, P = 0.966), green fodder yield per plot (G = 0.846, P = 0.757), grain yield per plant (G = 0.984, P = 0.966) at both levels. There was negative significant association with Fe content (G = -0.377, P = -0.349), Zn content (G = - 0.690, P = -0.514) at both levels.

The character panicle length had positive significant correlation with panicle girth (G= 0.905, P = 0.896), 1000 grain weight (G = 0.823, P = 0.910), green fodder yield per plant (G = 0.530, P = 0.685), harvest index (G = 0.7152, P=0.740), grain yield per plot (G= 0.732, P= 0.942), green fodder yield per plot (G= 0.535, P = 0.682), grain yield per plant (G= 0.812, P = 0.938). There was negative and significant association with iron content (G = -0.398, P = -0.297) and zinc content (G = -0.835, P = -0.414) at the both levels.

The character panicle girth had positive significant correlation with green fodder yield per plant (G = 0.664, P = 0.748), harvest index (G = 0.590, P = 0.570), 1000 grain weight (G = 0.894, P = 0.910), grain yield per plot (G = 0.987, P = 0.932), green yield per plot (G = 0.680, P = 0.744) and grain yield per plant (G = 0.988, P= 0.931). There was negative significant association with Fe content (G = -0.419, P = - 0.315), Zn content (G = - 0.808, P = - 0.425).

The character 1000 grain weight had positive significant correlation with green fodder yield per plant (G = 0.835, P= 0.741), harvest index (G = 0.643, P = 0.601) and grain yield per plot (G = 0.984, P = 0.970), green fodder yield per plot (G = 0.845, P = 0.736), grain yield per plant (G = 0.983, P = 0.970) at the both levels. There was negative significant correlation with Fe content (G = -0.369, P = -0.0.331), Zn content (G = 0.724, P = -0.521) at the both levels.

The character green fodder yield had positive significant association with grain yield per plot (G = 0.785, P = 0.734), Green fodder yield per plot (G = 0.683, P= 0.994), grain yield per plant (G = 0.785, P = 0.731) at the both level.

The character harvest index positive significant association with grain yield per plot (G = 0.650, P = 0.641), grain yield per plant (G = 0.644, P = 0.644) at the both levels.

The character grain yield per plot had positive significant correlation with green fodder yield per plot (G = 0.789, P = 0.733), grain yield per plant (G = 0.712, P = 0.999) at genotypic and phenotypic levels, respectively.

The character green fodder yield per plot significant correlation with grain yield per plant (G = 0.789, P = 0.730) at the both levels. There was negative significant association with Fe content (G = -0.371, P = -0.254) and Zn content (G =-0.751, P = -0.321) at the both levels.

The Fe content had positive significant with Zn content (G = 0.750 P = 0.651) at both levels. There was negative

significant association with grain yield per plant (G = -0.379, P = -0.339) at both levels.

The Zn content exhibited negative significant correlation with grain yield per plant (G = -0.721, P = -0.519) at both levels.

In the present investigation, the estimates of genotypic correlation coefficients were higher than the phenotypic correlation coefficients. Similar findings in pearl millet have been reported by Chaudhry*et al.* (2003) [1], Talawar *et al.* (2017) [9], Nehra *et al.* (2017) [6] and Singh and Singh (2016) [8]. The genotypic and phenotypic correlation of grain yield per plant exhibited significant positive correlation with plant height, panicle length, no. of productive tillers, panicle girth, 1000 grain weight, green fodder yield per plant, harvest index, grain yield per plot and green fodder yield per plant which showed that grain yield per plant can be improved through selection of these characters. Similar findings have been reported by Choudhari *et al.* (2012) [2] and Dapke *et al*. (2014) [3] for plant height and harvest index with grain yield per plant. Also Singh and Singh (2016) [8], Kaushik *et al*. (2018) [5] and Sharma *et al*. (2018) [7] observed similar finding for grain yield per plant with no. of productive tillers per plant, panicle length, and 1000 grain weight. Singh and Singh (2016) [8] and Sharma *et al*. (2018) [7] observed similar result for association between panicle girth and grain yield per plant.

Table 1: Genotypic correlation of grain yield per plant with its components in pearl millet

Characters	Days to 50% Flowering	Days to Maturity	Plant Height (cm)	No of productive tiller	Panicle length (cm)	Panicle Girth (cm)	1000 seed weight (g)	Green Fodder Yield Per Plant (g)	Harvest index (%)	Grain Yield per Plot (kg/plot)	Green fodder yield per plot (kg/plot)	Fe content (ppm)	Zn content (ppm)	Grain Yield per Plant (g)
Days to 50% Flowering	1.0000	0.986**	0.1735	0.1743	-0.0109	0.2112	0.1107	0.1027	0.253*	0.1107	0.0925	-0.1758	-0.422**	0.1191
Days to Maturity		1.0000	0.2141	0.1535	-0.0235	0.2158	0.0980	0.1224	0.1739	0.0990	0.1131	-0.2165	-0.411**	0.1098
Plant Height (cm)			1.0000	0.806**	0.644**	0.780**	0.846**	0.888**	0.0128	0.797**	0.755**	-0.409**	-0.710**	0.793**
No of productive tiller				1.0000	0.843**	0.834**	0.964**	0.836**	0.627**	0.985**	0.840**	-0.377*	-0.690**	0.984**
Panicle length (cm)					1.0000	0.905**	0.823**	0.530**	0.715**	0.732**	0.535**	-0.398*	-0.835**	0.812**
Panicle Girth (cm)						1.0000	0.894**	0.664**	0.590**	0.987**	0.680**	-0.419**	-0.808**	0.988**
1000 seed weight (g)							1.0000	0.835**	0.643**	0.984**	0.845**	-0.369*	-0.724**	0.983**
Green Fodder Yield Per Plant (g)								1.0000	-0.1231	0.785**	0.683**	-0.382*	-0.749**	0.785**
Harvest index (%)									1.0000	0.650**	-0.1300	-0.1819	-0.506**	0.644**
Grain Yield per Plot (kg/plot)										1.0000	0.789**	-0.384*	-0.732**	0.712**
Green fodder yield per plot (kg/plot)											1.0000	-0.371*	-0.751**	0.789**
Fe Content (ppm)												1.0000	0.750**	-0.379*
Zn Content (ppm)													1.0000	-0.721**
Grain Yield per Plant (g)														1.0000

*, ** denotes significance at 5% and 1% respectively

Table 2: Phenotypic correlation of grain yield per plant with its components in pearl millet

Characters	Days to 50% Flowering	Days to Maturity	Plant Height (cm)	No of productive tiller	Panicle length (cm)	Panicle Girth (cm)	1000 seed weight (g)	Green Fodder Yield Per Plant (g)	Harvest index (%)	Grain Yield per Plot (Kg/Plot)	Green fodder yield per plot (Kg/Plot)	Fe (ppm)	Zn (ppm)	Grain Yield per Plant (g)
Days to 50% Flowering	1.0000	0.985**	0.0474	0.1089	0.0261	0.1430	0.0780	0.0162	0.1000	0.0929	0.0215	-0.1318	-0.2166	0.0932
Days to Maturity		1.0000	0.0516	0.0881	0.0062	0.1308	0.0619	0.0099	0.0642	0.0771	0.0150	-0.1538	-0.2035	0.0787
Plant Height (cm)			1.0000	0.731**	0.615**	0.703**	0.716**	0.908**	0.1539	0.710**	0.908**	-0.327*	-0.405**	0.705**
No of productive tiller				1.0000	0.881**	0.918**	0.938**	0.758**	0.552**	0.966**	0.757**	-0.349*	-0.514**	0.966**
Panicle length (cm)					1.0000	0.896**	0.910**	0.685**	0.640**	0.942**	0.682**	-0.297*	-0.414**	0.938**
Panicle Girth (cm)						1.0000	0.910**	0.748**	0.570**	0.932**	0.744**	-0.315*	-0.425**	0.931**
1000 seed weight(g)							1.0000	0.741**	0.601**	0.970**	0.736**	-0.331*	-0.521**	0.970**
Green Fodder Yield Per Plant (g)								1.0000	0.1579	0.734**	0.994**	-0.248*	-0.319*	0.731**
Harvest index (%)									1.0000	0.641**	0.1608	-0.1524	-0.310*	0.644**
Grain Yield per Plot (Kg/Plot)										1.0000	0.733**	-0.341*	-0.515**	0.999**
Green fodder yield per plot (Kg/Plot)											1.0000	-0.254*	-0.321*	0.730**
Fe content (ppm)												1.0000	0.651**	-0.339*
Zn content (ppm)													1.0000	-0.519**
Grain Yield per Plant (g)														1.0000

*, ** denotes significance at 5% and 1% respectively

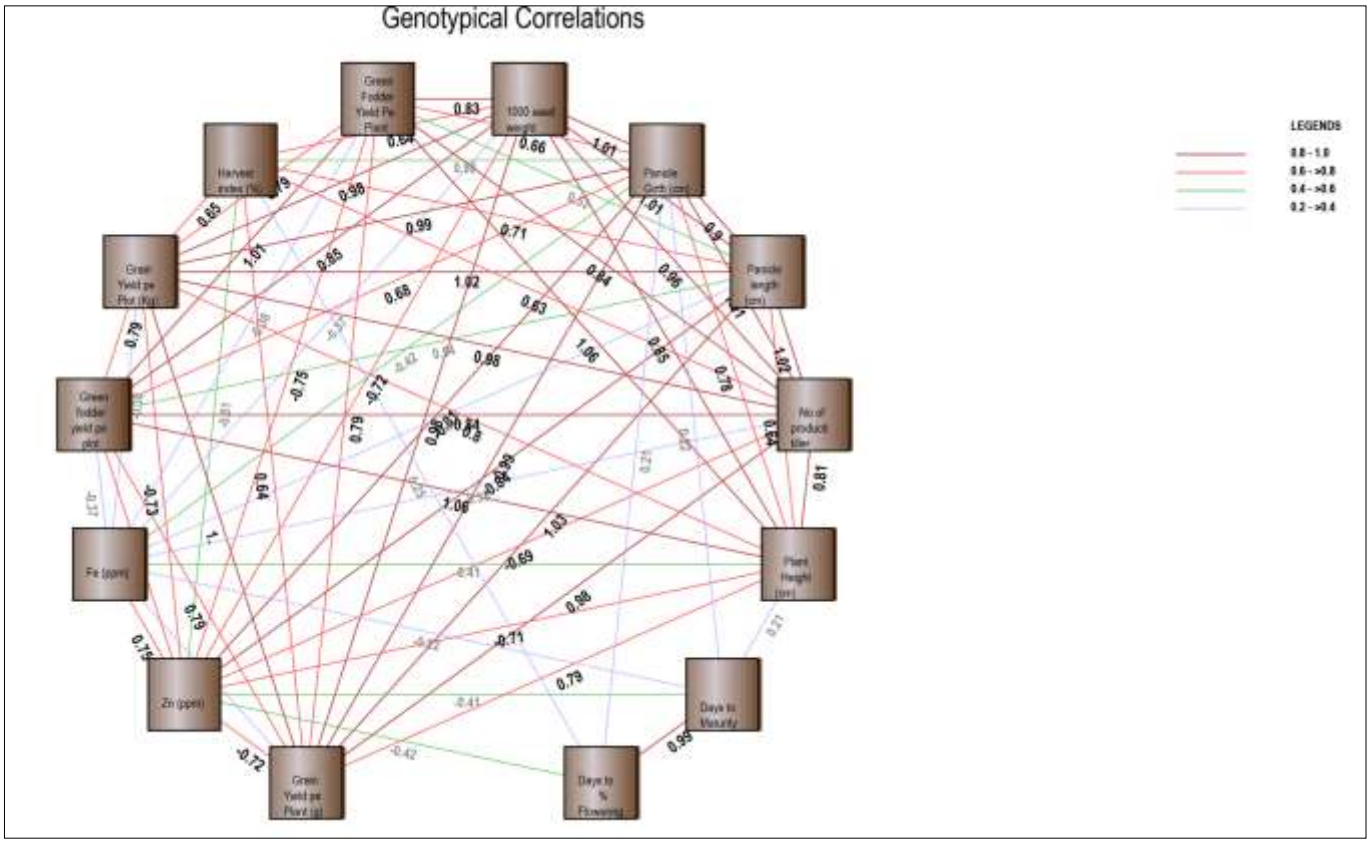

Fig 1: Genotypic correlation of grain yield per plant with its component in pearl millet

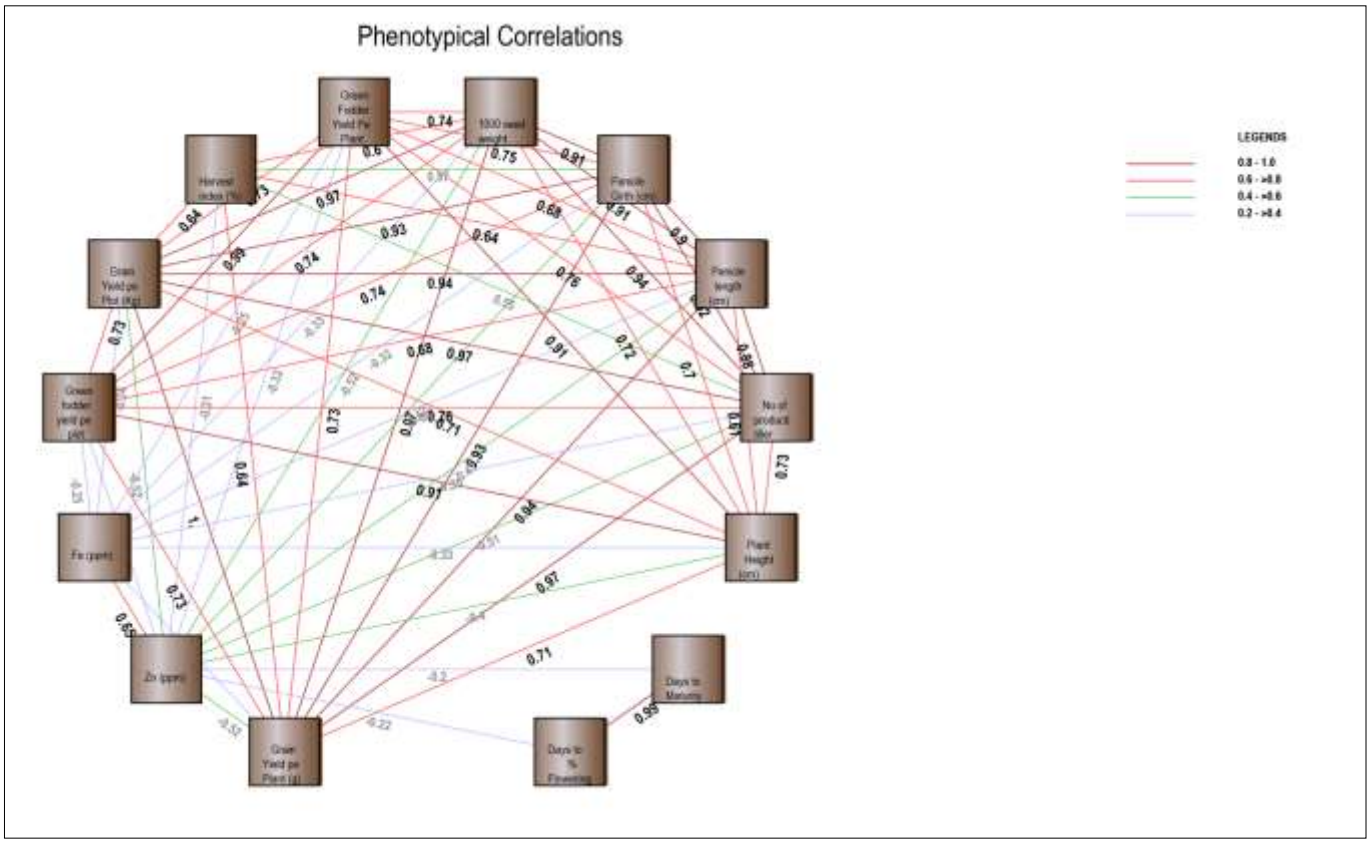

Fig 2: Phenotypic correlation of grain yield per plant with its components in pearl millet

Conclusion

Grain yield per plant had highly positive and significant correlation with panicle girth, no. of productive tillers per plant, 1000 grain weight, panicle length, plant height, green fodder per plot, green fodder yield per plant, grain yield per plot and harvest index at both the levels. It would be inferred that yield is function of these traits and selection for high yield would be effective through selection of these characters.

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