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Character association for grain yield and its components in pearl millet (*Pennisetum glaucum* L.)

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Abstract

The present investigation titled Character Association for Grain Yield and its Contributing Characters in Pearl Millet (*Pennisetum glaucum* L.) was conducted in Kharif 2021 at NARP, Aurangabad. (MH), VNMKV, Parbhani. Analysis of variance among 32 pearl millet genotypes showed high and significant variability among genotypes. Correlation results showed that grain yield was positively and significantly correlated with plant height, panicle length, test weight, grain yield per plot and harvest index at both levels. Mention that yield is a constraint of these traits and selection of these traits will result in increased grain yield. Grain yield was negatively and significantly correlated with panicle girth at both levels. showed an inverse relationship between these characters and concluded that selection based on panicle girth would also improve yield. Correlation between plant height, panicle length, test weight, grain yield per plot and harvest index at both levels. were positive and significant at both levels and it would be inferred that simultaneous enhancement of these traits by a single selection program is possible.

Keywords: Grain yield, pearl millet, *Pennisetum glaucum* L.

Introduction

Pearl millet, popularly called as millet, is a large coarse grain, a member of the Gramineae family and genus Pennisetum. That chromosome number is 2n = 14. It is believed to have originated in West Africa (Vavilov, 1950) [13]. It is a highly cross-pollinated crop with protogynous flowers and wind pollination, which fulfills the biological requirements for hybrid development. Pearl millet is one of the most important cultivated grains in the world, ranking sixth in area after rice, wheat, maize, barley and sorghum. This crop is grown on about 30 million hectares in more than thirty countries. Majority of this area is in Asia, Africa and America (Gupta *et al*., 2015) [6]. In India, pearl millet is the fourth most cultivated food crop after rice, wheat and maize. It covers 7.4 million hectares with an average yield of 9.13 million tonnes and a yield of 1237 kg/ha (Anonymous, 2019). It is used as fodder and fodder for livestock. Pearl millet is very rich in calories, protein (6-15%), fat (5-6%), carbohydrates (60-72%), fiber (1-1.8%) and minerals with low amount of hydrogen cyanide, which produces It is a highly nutritious and less suitable crop compared to other crops. Correlation and path covariance analysis are important biometrical techniques for determining income factors. Characters positively correlated with yield are important to the plant breeder for selection purposes. Correlations provide a measure of genetic association between characters and reveal traits useful as indices of selection. The correlation coefficient for all these indicates the nature of association between different traits. Therefore, close work was undertaken to elucidate the correlation of grain yield and yield traits in millet inbred lines.

Materials and Methods

The thirty two genotypes of pearl mill*et al*ong with two checks ABPC 4-3 and AIMP-92901 were grown in a RBD with three replications during *Kharif* 2021-22. Each genotype was sown in a four row of 1.5 m length with spacing of 45 cm between rows and 15 cm between plants.
Observations were recorded on five plants basis. The observations were recorded on days to 50% flowering, days to maturity, plant height (cm), No of productive tillers per plant, Panicle length (cm), Panicle girth (cm), test weight (g), Grain yield per plant (g), Grain yield per plot (kg/plot), Green fodder yield per plant (g), Green fodder yield / plot (kg/plot), Harvest index (%), Seed set under bagging (%), Fe content (ppm), Zn content (ppm).

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Statistical Analysis

The genotypic and phenotypic correlation coefficients were calculated from the genotypic and phenotypic components of variance and covariance as described by Singh and Choudhary (1985) [15] and as per formula given by Johnson *et al*., (1955) [4].

Results and Discussion

Correlation

Grain yield / plant recorded significant and positive association with plant height (G = 0.449, P = 0.380), grain yield per plot (G = 1.0135, P = 0.9876), panicle length (G = 0.8604, P = 0.7572), 1000 Grain weight (G = 0.8418, P = 0.7857), harvest index (G = 0.8074. P = 0.6524) at genotypic and phenotypic levels, respectively. There was significant but negative correlation with panicle girth (G = -0.5738, P = -0.4264) at genotypic and phenotypic levels. ergot (P = -0.2571) at phenotypic levels only. Grain yield per plant recorded non significant and positive association with green fodder yield (G = 0.2699, P = 0.2238), green fodder yield per plot (G = 0.2619, P = 0.2309) and Fe content (G = 0.0379, P = 0.0446) at genotypic and phenotypic levels, respectively. There was non significant and negative association with 50 % flowering (G = -0.065, P = -0.0451), days to maturity (G = -0.1748, P = -0.112), no. of productive tiller per plant (G = -0.3281, P = -0.093), seed setting under bagging (G = -0.261, P = -0.114), Zn content (G = -0.135, P = -0.1239) at genotypic and phenotypic level only.

The character days to 50 per cent flowering had significant and positive association with days to maturity (G = 0.9026, P = 0.85) and no.of tiller per plant (G = 1.404, P = 0.4442). at genotypic and phenotypic level, respectively. Non significant and positive association with green fodder yield per plant (G = 0.0049, P = 0.0466), and zinc content (G = 0.1545, P = 0.1486). at genotypic and phenotypic level, respectively. There was non significant and negative association with plant height (G = -0.0092, P = -0.005), panicle length (G = -0.1366, P = -0.0895), 1000 grain weight (G = -0.2282, P = -0.2176), grain yield per plot (G = -0.0575, P = -0.0594), harvest index (G = -0.2012, P = -0.145) and Fe content (G = -0.1323, P = -0.13). at genotypic and phenotypic level, respectively and fodder yield per plot (G = -0.002) at genotypic level, only.

The character plant height had positive significant correlation with panicle length (G = 0.5867, P = 0.4601), grain yield per plot (G = 0.4217, P = 0.3959), green fodder yield (G = 1.0488, P = 0.8282) and green fodder yield per plot (G = 1.006, P = 0.8511). at genotypic and phenotypic level. While no.of productive tiller (G = 0.3499) exhibited positive significant association only at genotypic level and 1000 grain weight (P = 0.2719) at phenotypic level. There was positive and non significant correlation with panicle girth (G = 0.2401, P = 0.1196), harvest index (G = 0.2231, P = 0.1714), and Fe content (G = 0.2025, P = 0.1912). At the both level. While 1000 grain weight (G = 0.2854) at genotypic level only and no.of productive tiller (P = 0.0665) at phenotypic level only. Negative and non significant correlation with seed setting under bagging (G = -0.031, P = -0.0591) and zinc content (G = -0.0793, P = -0.0687).at genotypic and phenotypic level, respectively.

The character panicle length had positive significant with 1000 grain weight (G = 0.8661, P = 0.787), grain yield per plot (G = 0.8531, P = 0.7627), green fodder yield (G = 0.4893, P = 0.3351), green fodder yield per plot (G = 0.4675, P = 0.3518) and harvest index (G = 0.8743, P = 0.5705) at both level. There was positive and non significant association with iron content (G = 0.1164, P = 0.1079) and zinc content (G = 0.0302, P = 0.023) at the both level. Negative and non significant association with panicle girth (G = -0.2344, P = -.0.1335), no.of productive plant tiller (G = -0.2904, P = -0.0512) and seed setting under bagging (G = -0.2331 P = -0.0808) at genotypic and phenotypic level, respectively. The character panicle girth had positive significant correlation with green fodder yield per plot (G = 0.39120 at the genotypic level. The trait no.of productive tiller per plant (G = 0.5326) and green fodder yield per plant (G = 0.421) had positive significant correlation at genotypic level only. There was negative significant association with 1000 grain weight (G = -0.4145, P = -0.3101) and grain yield per plot (G = -0.5504, P = -0.4484) at the both level. There was positive non significant association with sees setting under bagging (G = 0.1843, P = 0.0364) and zinc content (G = 0.2266, P = 0.1786) at the both levels and no.of productive tiller per plant (P = 0.0996), green fodder yield per plant (P = 0.2354) and green fodder yield per plot (P = 0.2429) at phenotypic level only. Negative and non significant association with iron content (G = -0.0395, P = -0.0426) at genotypic and phenotypic level, respectively.

The character 1000 grain weight had positive significant correlation with grain yield per plot (G = 0.8264, P = 0.7949) and harvest index (G = 0.8627, P = 0.6019) at the both levels. There was negative significant correlation with no.of productive tillers per plant (G = -0.6216, P = -0.1255) at the both levels. There was positive non significant association with green fodder yield (G = 0.2074, P = 0.1793), green fodder yield per plot (G = 0.1959, P = 0.1801) and iron content (G = 0.0023, P = 0.0038) at the both levels.

The character productive tiller per plant had positive significant correlation with zinc content (G = 0.568) at phenotypic level only. There was negative significant with harvest index (G = -0.4565) at genotypic level only. There was positive non significant correlation with green fodder yield (G = 0.2343, P = 0.0153) and green fodder yield per plot (G = 0.2057, P = 0.02) at both level and zinc content (P = 0.1977) and seed setting under bagging (P = 0.0555) at phenotypic level only. There was negative non significant association with grain yield per plot (G = -0.2705, P = -0.1187) and iron content (G = -0.1878, P = -0.0766) at both level and seed setting under bagging (G = -0.0102) at genotypic level only harvest index (P = -0.1473). at phenotypic level only.

The character grain yield per plot had positive significant correlation with harvest index (G = 0.8195, P = 0.6514) at genotypic and phenotypic level, respectively. There was positive non significant correlation with green fodder yield (G = 0.2703, P = 0.2183), green fodder yield per plot (G = 0.2614, P = 0.227) and iron content (G = 0.0411, P = 0.0462) at both levels, respectively. There was negative non significant association with seed setting under bagging (G = -0.2456, P = -0.1213) and zinc content (G = 0.1317, P = 0.1269) at both levels.

The character green fodder yield had positive significant association with green fodder yield per plot (G = 1.0054, P = 0.9965), at the both level, respectively. There was positive non significant association with harvest index (G = 0.1116, P = 0.0179) and iron content (G = 0.2124, P = 0.183) at the both level respectively, and seed setting under bagging (G =

0.1562) at genotypic only. There was negative non significant association with zinc content (G = -0.1581, P = -0.1183) at the both levels and seed setting under bagging (P = -0.0345) phenotypic level only.

The character green fodder yield per plot positive non significant association with harvest index (G = 0.1146, P = 0.0318) and iron content (G = 0.2124, P = 0.183) at the both levels and seed setting under bagging (G = 0.1279) at genotypic level only. There was negative non significant association with zinc content (G = -0.1501, P = 0.1232) at the both levels and seed setting under bagging (P = -0.0.048) at phenotypic level only.

The character harvest index positive non significant association with seed setting under bagging (G = 0.0149, P = 0.1657), iron content (G = 0.3085, P = 0.2251) at the both levels. The character seed setting under bagging positive significant correlation with iron content (G = 0.3757, P = 0.2497) at the both levels. There was positive non significant association with blast (G = 0.038, P = 0.0242) and zinc content (G = 0.1917, P = 0.1101) at the both levels. The Fe content had positive significant with Zn content (P = 0.285) at phenotypic level only. There was positive non significant association with zinc content (G = 0.2854) at genotypic level.

The potential productivity of any crop is basically valued in terms of grain yield per unit area. It is generally difficult to improve it through direct selection as yield depends on a large number of different constitutive characters as well as environmental factors. Therefore, it is necessary to estimate the relationship between constituent characters and grain yield. Thus the efficiency of selection can be increased if it is used simultaneously for component characters, which are related to yield. In quantitative traits, genotype is influenced by environment, which in turn influences phenotypic expression as well as association and the direction of association between the resulting traits. Knowledge of the magnitude and direction of correlation is used to determine how a change in one character will lead to simultaneous changes in other characters. A high magnitude of positive correlation coefficient at the genotypic level between constituent characters and grain yield is significant for indirect selection for grain yield. Since no suitable test of significance is available for genotypic correlation coefficient, more emphasis is given to phenotypic correlation coefficient, which is tested by 't-test'.

Although genotypic correlation coefficients were generally higher than their corresponding phenotypic correlation coefficients for many characters, in some cases phenotypic correlation coefficients were higher than genotypic ones, which may be due to environmental effects. Genotypic correlation provides a measure of the extent to which two traits are under the control of the same genes or have a common physiological basis for their expression. If the genotypic correlation is positive, selection practiced for improvement in one character will automatically result in improvement for others and so on. Knowledge of the relationship between grain yield and its constituents is essential, and selection for one constituent character may lead to simultaneous changes in another. Therefore, for a rational approach to improving income, gathering information on character association can be helpful.

In the present investigation, estimates of genotypic correlation coefficients were higher than those of phenotypic correlation coefficients. Genotypic and phenotypic correlation of grain yield per plant exhibited significant positive correlation with plant height, panicle length, 1000 grain weight, grain yield per plot and harvest index which indicated that grain yield could be improved through selection of these characters. Similar findings have been reported by Vidhyadar *et al.* (2007) [14], Kumar *et al.* (2014) [5], Singh *et al.* (2015) [11], Kumar *et al.* (2016) [6], Singh *et al.* (2018) [12], Rasitha *et al.* (2019) [9], Annamalai *et al.* (2020) [1] and Dadarwal *et al.* (2020) [2].

Table 1: Genotypic correlation of grain yield with yield contributing characters in pearl millet.

Characters	Days to Flowering	Days to Maturity	Plant Height (cm)	Panicle Length (cm)	Panicle Girth (cm)	Test Weight (g)	No. of Productive tillers per plant	Grain Yield per plot (kg/plot)	Green Fodder Yield Per Plant (g)	Green Fodder Yield Per Plot (kg/plot)	Harvest Index (%)
Days to 50% Flowering	1.000										
Days to Maturity	0.9026 **	1.000									
Plant Height (cm)	0.0092 NS	0.0165 NS	1.000								
Panicle Length (cm)	-0.1366 NS	-0.1781 NS	0.5867 **	1.000							
Panicle Girth (cm)	0.0591 NS	0.1514 NS	0.2401 NS	-0.2344 NS	1.000						
1000 Grain Weight (g)	-0.2282 NS	-0.2427 NS	0.2854 NS	0.8661 **	-0.4145 *	1.000					
No. Of Productive Tillers Per Plant	1.404 **	1.6456 **	0.3499 *	-0.2904 NS	0.5326 **	-0.6216 **	1.000				
Grain Yield Per Plot (kg/plot)	-0.0575 NS	-0.1666 NS	0.4217 *	0.8531 **	-0.5504 **	0.8264 **	-0.2705 NS	1.000			
Green Fodder Yield Per Plant (g)	0.0049 NS	0.0374 NS	1.0488 **	0.4893 **	0.421 *	0.2074 NS	0.2343 NS	0.2703 NS	1.000		
Green Fodder Yield Per Plot	-0.002 NS	0.0285 NS	1.006 **	0.4675 **	0.3912 *	0.1959 NS	0.2057 NS	0.2614 NS	1.0054 **	1.000	

(kg/plot)											
Harvest Index (%)	-0.2012 NS	-0.3112 NS	0.2231 NS	0.8743 **	-0.4183 *	0.8627 **	-0.4565 **	0.8195 **	0.1116 NS	0.1146 NS	1.000
Seed Setting under Bagging (%)	0.1873 NS	0.2076 NS	-0.031 NS	-0.2331 NS	0.1843 NS	-0.1676 NS	-0.0102 NS	-0.2456 NS	0.1562 NS	0.1279 NS	0.0149 NS
Fe Content (ppm)	-0.1323 NS	-0.1151 NS	0.2025 NS	0.1164 NS	-0.0395 NS	0.0023 NS	-0.1878 NS	0.0411 NS	0.2134 NS	0.2124 NS	0.3085 NS
Zn Content (ppm)	0.1545 NS	0.2576 NS	-0.0793 NS	0.0302 NS	0.2266 NS	-0.1005 NS	0.5683 **	-0.1317 NS	-0.1581 NS	-0.1501 NS	-0.0939 NS
Grain Yield Per Plant (g)	-0.065 NS	-0.1748 NS	0.4449 *	0.8604 **	-0.5738 **	0.8418 **	-0.3281 NS	1.0135 **	0.2699 NS	0.2619 NS	0.8074 **

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

Characters	Seed Setting under Bagging (%)	Fe Content (ppm)	Zn Content (ppm)	Grain Yield Per Plant (g)
Days to Flowering				
Days to Maturity				
Plant Height (cm)				
Panicle Length (cm)				
Panicle Girth (cm)				
1000 Grain Weight (g)				
No. Of Productive Tillers Per Plant				
Grain Yield Per Plot (g)				
Green Fodder Yield Per Plant (g)				
Green Fodder Yield Per Plant (g)				
Harvest Index (%)				
Seed Setting under Bagging (%)	1.000			
Fe Content (ppm)	0.3757 *	1.000		
Zn Content (ppm)	0.1917 NS	0.2854 NS	1.000	
Grain Yield Per Plant (g)	-0.261 NS	0.0379 NS	-0.135 NS	1.000

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

Table 2: Phenotypic correlation of grain yield with yield contributing characters in pearl millet.

Characters	Days to Flowering	Days to Maturity	Plant Height (cm)	Panicle Length (cm)	Panicle Girth (cm)	1000 Grain Weight (g)	No. of Productive Tillers Per Plant	Grain Yield Per Plot (kg/plot)	Green Fodder Yield Per Plant (g)	Green Fodder Yield Per Plot (kg/plot)
Days to Flowering	1.000									
Days to Maturity	0.85 **	1.000								
Plant Height (cm)	-0.005 NS	0.0367 NS	1.000							
Panicle Length (cm)	-0.0895 NS	-0.1346 NS	0.4601 **	1.000						
Panicle Girth (cm)	0.0832 NS	0.1257 NS	0.1196 NS	-0.1335 NS	1.000					
1000 Grain Weight (g)	-0.2176 NS	-0.2126 NS	0.2719 *	0.787 **	-0.3101	1.000				
No. Of Productive Tillers Per Plant	0.4442 **	0.5711 **	0.0665 NS	-0.0512 NS	0.0996 NS	-0.1255 NS	1.000			
Grain Yield Per Plot	-0.0594 NS	-0.1252 NS	0.3959 **	0.7627 **	-0.4484 **	0.7949 **	-0.1187 NS	1.000		
Green Fodder Yield Per Plant (g)	0.0466 NS	0.0513 NS	0.8282 **	0.3351 **	0.2354 NS	0.1793 NS	0.0153 NS	0.2183 NS	1.000	
Green Fodder Yield Per Plot (kg/plot)	0.0343 NS	0.0427 NS	0.8511 **	0.3518 **	0.2429 NS	0.1801 NS	0.02 NS	0.227 NS	0.9965 **	1.000
Harvest Index (%)	-0.145 NS	-0.1054 NS	0.1714 NS	0.5705 **	-0.2213 NS	0.6019 **	-0.1473 NS	0.6514 **	0.0179 NS	0.0318 NS
Seed Setting under Bagging (%)	0.0672 NS	0.1708 NS	-0.0591 NS	-0.0808 NS	0.0364 NS	-0.1144 NS	0.0555 NS	-0.1213 NS	-0.0618 NS	-0.048 NS
Fe Content (ppm)	-0.13 NS	-0.1076 NS	0.1912 NS	0.1079 NS	-0.0426 NS	0.0038 NS	-0.0766 NS	0.0462 NS	0.1698 NS	0.183 NS
Zn Content (ppm)	0.1486 NS	0.2519 *	-0.0687 NS	0.023 NS	0.1786 NS	-0.0982 NS	0.1977 NS	-0.1269 NS	-0.1183 NS	-0.1232 NS
Grain Yield Per Plant (g)	-0.0451 NS	-0.112 NS	0.38 **	0.7572 **	-0.4264 **	0.7857 **	-0.0993 NS	0.9876 **	0.2238 NS	0.2309 NS

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

Characters	Harvest Index (%)	Seed Setting Under Bagging (%)	Fe Content (%)	Zn Content (%)	Grain Yield Per Plant (g)
Days to Flowering					
Days to Maturity					
Plant Height (cm)					
Panicle Length (cm)					
Panicle Girth (cm)					
1000 Grain Weight (g)					
No. Of Productive Tillers Per Plant					
Grain Yield Per Plot (kg/plot)					
Green Fodder Yield Per Plant (g)					
Green Fodder Yield Per Plot (kg/plot)					
Harvest Index (%)	1.000				
Seed Setting under Bagging (%)	0.1657 NS	1.000			
Fe Content (ppm)	0.2251 NS	0.2497 *	1.000		
ZN Content (ppm)	-0.0643 NS	0.1101 NS	0.285 *	1.000	
Grain Yield Per Plant (g)	0.6524 **	-0.114 NS	0.0446 NS	-0.1239 NS	1.000

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

Conclusion

Correlation results concluded that grain yield was positively and significantly associated with plant height, panicle length, test weight, grain yield per plot and harvest index at both levels. Show that yield is a function of these characters and that selection for these characters will complete to improve grain yield. Grain yield was negatively and significantly correlated with panicle girth at both levels. Showed previous relationships between these characters and concluded that selection based on panicle girth would also improve yield. Correlation between plant height, panicle length, test weight, grain yield per plot and harvest index at both levels. Were positive and significant at both levels and it would be inferred that concurrent development of these characters was possible through the same selection strategy.

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