# Deciphering trait association and their effect on yield, yield attributing and quality traits in barnyard millet [*Echinochloafrumentacea*(Roxb.) Link]


## ABSTRACT

Barnyard millet is viewed as a climate-resilient crop comprising high nutrient content and antioxidant properties therefore, it considered as a functional food crop. In the present study, thirty genotypes of barnyard millet were evaluated in Randomized Complete Block Design with an aim to decipher character association and cause and effect relationship among yield and yield attributing traits at Experimental Area of Division of Plant Breeding and Genetics, Faculty of Agriculture, SKUAST-J, Main Campus, Chatha, Jammu during *kharif* 2021. Results revealed that grain yield exhibited high positive correlation with panicle weight implying attention that this trait will help in improving yield in barnyard millet. Panicle weight showed highly significant positive correlation with flag leaf width, flag leaf area, panicle length and test weight revealing that selection for any one of these traits will contribute in improvement of all the other major component trait and overall yield. Peduncle length alone expressed negative significant correlation with grain yield. The cause and effect results revealed that test weight, days to 50% flowering, number of productive tillers, panicle weight, panicle length and flag leaf area had positive direct effect on grain yield per plant. It can be concluded that panicle weight is the most important component character in barnyard millet because of its high significant positive association with grain yield, its high direct effect on grain yield and being the most used path by the other component traits contributing positively towards grain yield.



*Keywords: millet, correlation, panicle, path, association*


## 1. INTRODUCTION

Millets are the oldest cultivated food known to humans and have traditionally been the prime component of the food basket of the poor people in India. Barnyard millet is an important short durationnutri-cereal. It is generally grown in warm and temperate climates around the world, particularly in India, Japan, China and Korea. It is mainly grown in India; in Himalayan region of Uttarakhand in the north and other in the Deccan plateau region of Tamil Nadu in the south (Sood *et al.,* 2015). Because of its resistance to drought and fast growth and exceptional nutritional properties, barnyard millet is an important crop for marginal farmers of Asian countries. It is a short duration crop that can be grown in poor environmental conditions with little input having tolerance against variety of biotic and abiotic stresses (Renganathan *et al.,* 2020). Further these characteristic enabled barnyard millet as a good

supplementary crop for subsistence farming as well as an alternative crop during monsoon crop failure.

Knowledge on trait association studies for yield and its component traits is essential while aiming yield improvement through selection. Vegetative characters which are positively associated with reproductive traits assist in selection at the early growth stage of crop. Unfavourable associations with desirable component traits may also be identified so as to avoid genetic slippage (Wang *et al*., 2011). Besides, path coefficient analysis is helpful to recognize direct and indirect association of traits and also enables comparison of causal factors for their relative contributions. Keeping the above facts in mind the present investigation was carried out to study the association between yield and its contributing traits in barnyard millet.

## 2. MATERIALS AND METHODS

The present experiment was carried out at Experimental Farm of Division of Plant Breeding and Genetics, Faculty of Agriculture, SKUAST-J, Main Campus, Chatha, Jammu during *kharif* 2021. The experimental material comprised of 30 genotypes of Barnyard millet procured from IIMR Hyderabad as well as collected from different locations of Jammu region of J&K (Table 1). These genotypes were evaluated in Randomized Complete Block Design (RCBD) in three replications having a plot size of $1m^2$ with row to row spacing of 25cm. All agronomic and plant protection measures were followed to raise a good crop as per package and practices. Data was recorded for 14 different quantitative characters as per DUS guidelines for barnyard millet provided by Protection of Plant Varieties and Farmer's Rights (PPV & FR) Authority, India (https://www. plantauthority.gov.in/). Genotypic correlation coefficients and phenotypic correlation coefficients were estimated following Hazel *et al*. (1943) while path coefficient analysis was carried out according to Wright, 1921.

**Table 1. List of 30 barnyard genotypes with sources**

| ***S. no.*** | ***Genotype*** | ***Source*** | ***S. no.*** | ***Genotype*** | ***Source*** |
|---|---|---|---|---|---|
| **1** | VL-207 | IIMR, Hyderabad | 16 | DHBM 93-3 | IIMR, Hyderabad |
| **2** | VL-172 | IIMR, Hyderabad | 17 | DHBM 93-2 | IIMR, Hyderabad |

| | | | | | |
|---|---|---|---|---|---|
| **3** | VL-181 | IIMR, Hyderabad | 18 | DHBM 23-3 | IIMR, Hyderabad |
| **4** | C0-2 | IIMR, Hyderabad | 19 | BM-2-17 | IIMR, Hyderabad |
| **5** | PRJ-1 | IIMR, Hyderabad | 20 | BM -29-17 | IIMR, Hyderabad |
| **6** | IEC-217 | IIMR, Hyderabad | 21 | JBM-1 | Local Germplasm Collection |
| **7** | IIMR-BM-3-1920 | IIMR, Hyderabad | 22 | JBM-2 | Local Germplasm Collection |
| **8** | IIMR-BM-8-1920 | IIMR, Hyderabad | 23 | JBM-3 | Local Germplasm Collection |
| **9** | BAR-1452 | IIMR, Hyderabad | 24 | JBM-4 | Local Germplasm Collection |
| **10** | 189-1(46) | IIMR, Hyderabad | 25 | JBM-5 | Local Germplasm Collection |
| **11** | 189-2(47) | IIMR, Hyderabad | 26 | JBM-6 | Local Germplasm Collection |
| **12** | BAR 1456 | IIMR, Hyderabad | 27 | JBM-7 | Local Germplasm Collection |
| **13** | BAR 1446 | IIMR, Hyderabad | 28 | JBM-8 | Local Germplasm Collection |
| **14** | BAR1012 | IIMR, Hyderabad | 29 | JBM-9 | Local Germplasm Collection |
| **15** | BAR1396 | IIMR, Hyderabad | 30 | JBM-10 | Local Germplasm Collection |



## 3. RESULTS AND DISCUSSION

Genotypic and phenotypic correlation coefficients estimated for grain yield per plant along with all yield attributing and quality traits are illustrated in **Table 2** and **Figure 1**. Genotypic correlation coefficients were found to be higher than the phenotypic

correlation coefficient for all the traits indicating that polygenes governing the traits were similar and influence of environment for the trait expression was minimal.

Grain yield showed high positive correlation with panicle weight for both genotypic and phenotypic correlation ($r_g$=0.541 &$r_p$=0.512) implying that attention to this trait will help in improvement of yield in barnyard millet. Traits such as flag leaf area, panicle length, number of productive tillers, days to maturity, iron content explicit non-significant but positive correlation. Some of the traits showed significant positive phenotypic correlation i.e., flag leaf width and test weight. Similar results were also reported by Arunachalam *et al.* (2012); Gupta *et al.* (2009); Upadhaya*et al.* (2014); Sood *et al,* (2015); Joshi *et al.* (2015) and Arya *et al.* (2017) in barnyard millet. Such positive association suggested that increase in one component character will increase grain yield per plant in barnyard millet. A trait viz., peduncle length recorded a significant negative association with grain yield. These results are in accordance with the findings of Mahto *et al,* (2000) and Gowda *et al.* (2008) in finger millet and Prabu *et al*., (2020) in barnyard millet. Whereas, the traits days to flowering, plant height, zinc content showed non- significant negative association. Negative association of grain yield with component traits suggested improvement in that character will decrease the grain yield per plant in barnyard millet.

The major yield contributing trait revealed by correlation studies i.e., panicle weight showed highly significant positive correlation with flag leaf width, flag leaf area, panicle length and test weight. Therefore, selection for any one trait will contribute in improvement of all the other major component trait and overall yield. Besides, it was also observed that plant height was positively associated with flag leaf width, flag leaf area and peduncle length of which flag leaf width contributed in producing lengthier panicle and peduncle and panicle weight contributing in yield. Association of days to 50% flowering and days to maturity with number of tillers revealed negative association as more vegetative growth delays onset of reproductive phase hence grain yield. For the biochemical traits i.e., iron and zinc content, highly significant positive correlation was observed for both genotypic and phenotypic correlation ($r_g$=0.473 &$r_p$=0.470) implying increase in one trait will increase in another trait.

Correlation among different desirable traits is further precisely divided into direct and indirect effects through path analysis which helps in strategizing breeding procedure for simultaneous selection aiming to improvement in every crop. Correlation among

different desirable traits is further precisely divided into direct and indirect effects through path analysis which helps in strategizing breeding procedure for simultaneous selection aiming to improvement in every crop. Path coefficient analysis as outlined by Dewey and Lu (1959) was carried out to split the correlation coefficients in to measure the direct and indirect effects. The estimated coefficients were then categorized as negligible, low, moderate, high and very high based on the scales suggested by Lenka and Mishra (1973).

Thus, path analysis provides the information about yield components and their relative importance. Since the magnitude of genotypic correlation coefficients was desirable and was found higher than phenotypic correlation coefficients for most of the character pairs, only genotypic correlation coefficients were considered for path analysis.

The direct and indirect contribution of each component character towards grain yield per plant in barnyard millet is presented in **Table 3**. Test weight (0.935), days to 50% flowering (0.823), number of productive tillers (0.732), panicle weight (0.459), panicle length (0.115) and flag leaf area (0.036) had positive direct effect on grain yield per plant. On the other hand, flag leaf length (-0.413), flag leaf width (-0.430), peduncle length (-0.607), days to maturity (-0.358) and plant height (-0.205) had direct negative effect on the grain yield per plant.

## 4. CONCLUSION

From the above results, thus it became clear that direct selection based on panicle weight may help in augmenting grain yield in the experimental material, whereas test weight, days to 50% flowering, number of productive tillers, panicle length and flag leaf area are the most important characters for indirect selection.

It can be concluded that panicle weight is the most important component character in barnyard millet because of its high significant positive association with grain yield, its high direct effect on grain yield and being the most used path by the other component traits contributing positively towards grain yield.

| | | DF | FL | FW | FLA | PEDL | PANL | NPT | DTM | PH | PW | TW | IRON | ZINC | GYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|



**Table 2. Genotypic and phenotypic correlation coefficients among yield, yield attributing and quality traits in barnyard millet**

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DF** | $r_g$ | 1 | 0.789** | -0.903** | -0.839** | 0.522** | -0.565** | 0.819** | 0.809** | -0.811** | -0.568** | -0.858** | -0.469** | -0.661** | -0.115 |
| | $r_p$ | 1 | 0.775** | -0.892** | -0.828** | 0.516** | -0.548** | 0.774** | 0.800** | -0.779** | -0.564** | -0.852** | -0.468** | -0.658** | -0.105 |
| **FL** | $r_g$ | | 1 | -0.720* | -0.509** | 0.539** | -0.302 | 0.653** | 0.525** | -0.604** | -0.530** | -0.769** | -0.368* | -0.488** | -0.384* |
| | $r_p$ | | 1 | -0.706** | -0.492* | 0.528** | -0.279** | 0.619** | 0.508** | -0.578** | -0.523** | -0.754** | -0.361** | -0.480** | -0.332** |
| **FW** | $r_g$ | | | 1 | 0.950** | -0.466** | 0.700** | -0.783** | -0.661** | 0.646** | 0.796** | 0.936** | 0.360 | 0.618** | 0.295 |
| | $r_p$ | | | 1 | 0.940** | -0.456** | 0.674** | -0.735** | -0.644** | 0.618** | 0.785** | 0.921** | 0.3566** | 0.612** | 0.263* |
| **FLA** | $r_g$ | | | | 1 | -0.374* | 0.768** | -0.743** | -0.651** | 0.575** | 0.710** | 0.846** | 0.3946* | 0.655** | 0.152 |
| | $r_p$ | | | | 1 | -0.368** | 0.741** | -0.698** | -0.631** | 0.553** | 0.699** | 0.829** | 0.388** | 0.645** | 0.128 |
| **PEDL** | $r_g$ | | | | | 1 | -0.167 | 0.443* | 0.225 | -0.416* | -0.440* | -0.394* | -0.199 | -0.263 | -0.473** |
| | $r_p$ | | | | | 1 | -0.164 | 0.424** | 0.215* | -0.400** | -0.436** | -0.388** | -0.195 | -0.260* | -0.424** |
| **PANL** | $r_g$ | | | | | | 1 | -0.549** | -0.404* | 0.522** | 0.545** | 0.579** | 0.142 | 0.445* | 0.031 |
| | $r_p$ | | | | | | 1 | -0.498** | -0.388** | 0.485** | 0.529** | 0.548** | 0.138 | 0.429** | 0.023 |
| **NPT** | $r_g$ | | | | | | | 1 | 0.595** | -0.618** | -0.526** | -0.752** | -0.338 | -0.737** | 0.081 |
| | $r_p$ | | | | | | | 1 | 0.553** | -0.567** | -0.492** | -0.710** | -0.317** | -0.693** | 0.119 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DTM** | $r_g$ | | | | | | | | 1 | -0.630** | -0.356 | -0.583** | -0.484** | -0.575** | 0.023 |
| | $r_p$ | | | | | | | | 1 | -0.588** | -0.353** | -0.575** | -0.480** | -0.566** | 0.005 |
| **PH** | $r_g$ | | | | | | | | | 1 | 0.331 | 0.618** | 0.4327* | 0.511** | -0.062 |
| | $r_p$ | | | | | | | | | 1 | 0.3196** | 0.586** | 0.413** | 0.493** | -0.060 |
| **PW** | $r_g$ | | | | | | | | | | 1 | 0.686** | 0.184 | 0.305 | 0.541** |
| | $r_p$ | | | | | | | | | | 1 | 0.677** | 0.183 | 0.303** | 0.512** |
| **TW** | $r_g$ | | | | | | | | | | | 1 | 0.373* | 0.587** | 0.328 |
| | $r_p$ | | | | | | | | | | | 1 | 0.370* | 0.583** | 0.2946** |
| **IRON** | $r_g$ | | | | | | | | | | | | 1 | 0.473** | 0.073 |
| | $r_p$ | | | | | | | | | | | | 1 | 0.470** | 0.072 |
| **ZINC** | $r_g$ | | | | | | | | | | | | | 1 | -0.058 |
| | $r_p$ | | | | | | | | | | | | | 1 | -0.056 |

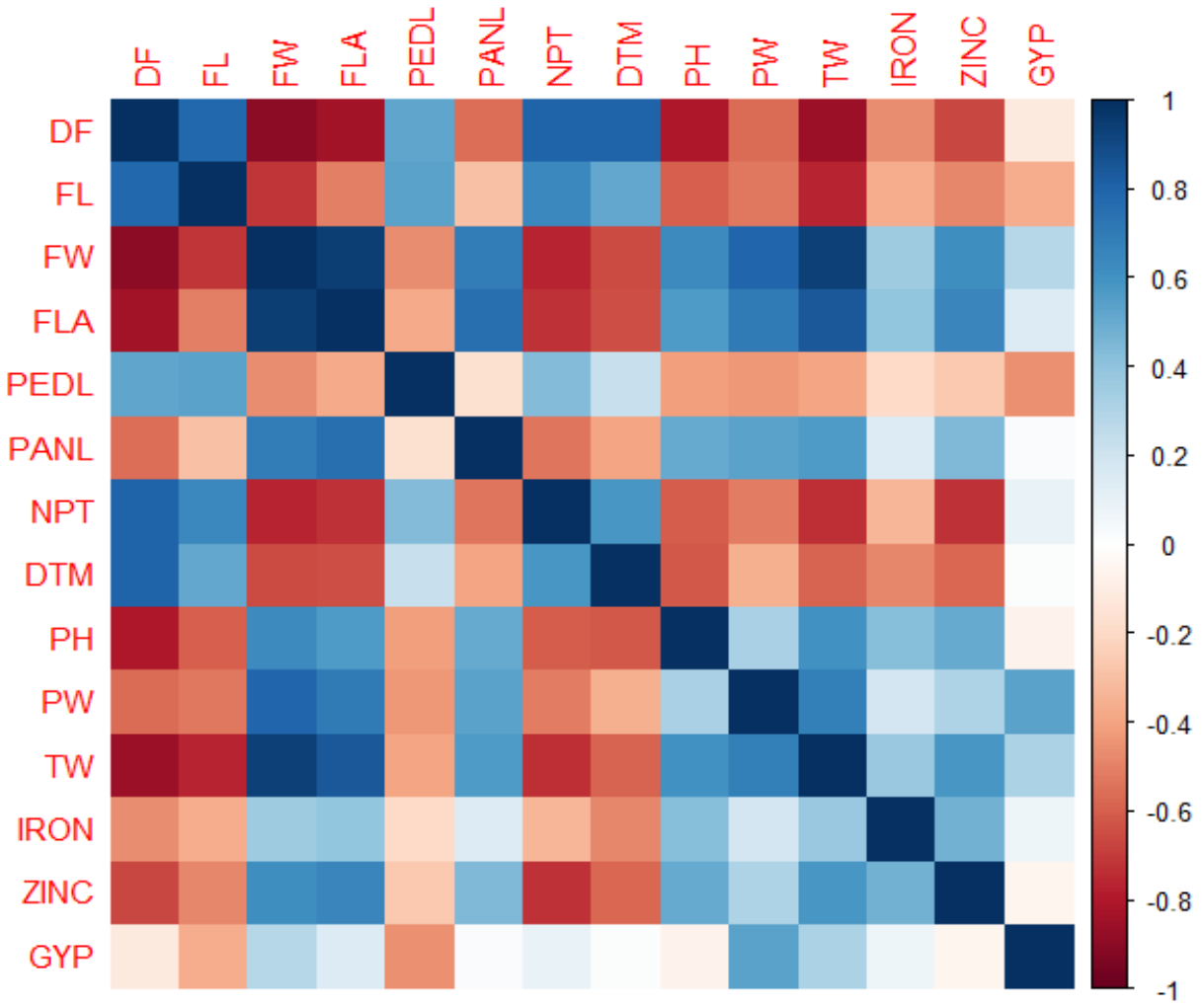
*, ** Significant at 5% and 1% level of significance, respectively, NS=non-significant
rg= Genotypic correlation coefficient; rp= Phenotypic correlation coefficient
**DF**= Days to 50% flowering, **FL**= Flag leaf length (cm), **FW**= Flag leaf width (cm), **FLA**= Flag leaf area (cm), **PEDL**= Peduncle length (cm), **PANL**= Panicle length (cm), **NPT** = Number of productive tillers, **DTM**= Days to maturity, **PH**= Plant height (cm), **PW**= Panicle weight (g), **TW**= Test weight (g), **IRON**= Iron content (mg/100g), **ZINC=** Zinc content (mg/100g), **GYP**= Grain yield per plant

**Table 3-Direct and indirect effect of different quantitative characters on grain yield in barnyard millet**

| | Days to 50% flowering | Flag leaf length (cm), | Flag leaf width (cm) | Flag leaf area (cm) | Peduncle length (cm) | Panicle length (cm) | Number of productive tillers | Days to maturity | Plant height (cm) | Panicle weight (g) | Test weight (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Days to 50% flowering** | **0.823** | -0.326 | 0.388 | -0.030 | -0.317 | -0.065 | 0.599 | -0.289 | 0.166 | -0.261 | -0.803 |
| **Flag leaf length (cm)** | 0.650 | **-0.413** | 0.310 | -0.018 | -0.327 | -0.034 | 0.478 | -0.188 | 0.124 | -0.244 | -0.720 |
| **Flag leaf width (cm)** | -0.744 | 0.298 | **-0.430** | 0.034 | 0.283 | 0.081 | -0.573 | 0.236 | -0.132 | 0.366 | 0.876 |
| **Flag leaf area (cm)** | -0.691 | 0.210 | -0.409 | **0.036** | 0.227 | 0.088 | -0.543 | 0.233 | -0.118 | 0.326 | 0.791 |
| **Peduncle length (cm)** | 0.430 | -0.223 | 0.200 | -0.013 | **-0.607** | -0.019 | 0.324 | -0.080 | 0.085 | -0.202 | -0.369 |
| **Panicle length (cm)** | -0.465 | 0.125 | -0.301 | 0.028 | 0.101 | **0.115** | -0.402 | 0.144 | -0.107 | 0.250 | 0.542 |
| **Number of productive tillers** | 0.675 | -0.270 | 0.337 | -0.027 | -0.269 | -0.063 | **0.732** | -0.213 | 0.127 | -0.241 | -0.704 |
| **Days to maturity** | 0.667 | -0.217 | 0.284 | -0.023 | -0.137 | -0.046 | 0.435 | **-0.358** | 0.129 | -0.163 | -0.546 |
| **Plant height (cm)** | -0.668 | 0.250 | -0.278 | 0.020 | 0.253 | 0.060 | -0.452 | 0.225 | **-0.205** | 0.152 | 0.579 |
| **Panicle weight** | -0.468 | 0.219 | -0.342 | 0.025 | 0.267 | 0.063 | -0.385 | 0.127 | -0.068 | **0.459** | 0.642 |

| (g) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Test weight (g)** | -0.707 | 0.318 | -0.402 | 0.030 | 0.239 | 0.067 | -0.550 | 0.209 | -0.127 | 0.315 | **0.935** |

**Figure 1- Correlation between yield and quality traits depicting the amount of association**

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