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# CORRELATION AND PATH CO-EFFICIENT ANALYSESFOR YIELD AND ITS CONTRIBUTING TRAITS IN FINGER MILLET(*ELEUSINE CORACANA* (L.) GAERTN) AT SAMARU IN THE NORTHERN GUINEA SAVANNA OF NIGERIA

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**Abstract**

The treatments consisted of three seed rates (3, 6, 9 kg ha$^{-1}$), two sowing methods (broadcasting, dibbling) and three poultry manure rates. The experiment was laid out in a split plot design with three replications. A factorial combination of sowing method and poultry manure rate constituted the main plot, while seed rate occupied the subplots.In all the years, there was a strong andpositivesignificant correlation between grain yield and plant height, leaf area index, number of tillers per plant, crop growth rate, panicle length, number of fingers per plant, productive tiller per plant, harvest index, 1000 grain weight, straw yieldhectare, panicle yield per hectare and negatively correlated with cumulative weed density and dry weight. The partitioning of correlation into direct and indirect contributions showed that, productive tillers per plantmadehighest direct contribution to grain yield of finger millet, while productive tillers per plant via harvest index, made the greatest indirect contribution to grain yield. Similarly, the highestindividual percent contributionsto grain yield was made by productive tillers per plant and the combined contribution was from productive tillers per plant via harvest index. Correlation and path analysis revealed that, productive tillers per plant and harvest index are theimportant yield contributing traits therefore due critical emphasis needs be given to these traits while selecting for grain yield improvement in finger millet.

**Keyword:** correlation, path co-efficient, finger millet

## INTRODUCTION

Millet is a small seeded annual grass that are cultivated as grain crops, primarily on marginal lands in dry areas in temperate, subtropical and tropical regions (Baker, 2003). It include five genera of thePoaceaefamily namely; *Panicum, Setaria, Echinochloa, Pennesetum and Eleusine*. The most important cultivated species are: Proso millet *(Panicum miliaceum)*, Foxtail millet *(Setaria italica)*, Japanese barnyard millet *(Echinochloa frumentacea)*, Finger millet *(Eleusine coracana)* and Koda millet *(Paspalum scrobiculatum).*

Finger millet is one of the minor cereals known with several health benefits which are attributed to its high level of polyphenol, dietary fibre, minerals and essential amino acids. Epidemiological studies have demonstrated that regular consumption of whole grain and their products can protect against the risk of cardiovascular diseases, type II diabetes, obesity, gastrointestinal cancers, anti-tumerogenic, atherosclerogenic effects, antioxidant and microbial properties and a range of other disorders (McKeown,2002).

Among the tropical cereals, finger millet provides the best quality malt for local brewing and is more preferred than maize or sorghum. The malt has good taste, easily digested, rich in amino acids and is an ideal base food for people of all age categories (Anon.,1996). In West Africa, finger millet is cultivated in a wide geographical zone stretching from Senegal, Niger and Nigeria (Glew *et al.*, 2008).In Nigeria, the crop is grown mainly around southern part of Kaduna in the southern Guinea savanna and in the highland of Jos Plateau in the north – central Nigeria, with an average yield of 580-785kg/ha under sole cropping (Glew *et al.*, 2008). The crop remained unknown and unstudied in the country, presently becoming extinct.

Considering its medicinal and nutritional importance as potential national food security, adequate information on variability andinterrelationship between yield and its attributes is meagre in finger millet. The path coefficient analysis initially suggested by Wright (1921) and described by Dewey and Lu (1959) allows partitioning of path coefficient analysis into direct and indirect contributions (effects) of various traits towards dependent variable and thus helps in assessing the cause-effect relationship as well as effective selection. Hence, this study is aimed to analyse and determine the traits having interrelationship with grain yield in finger millet,utilizing the correlation and path analysis. Therefore, the present investigation was undertaken to study the relative contribution of different yield attributes to grain yield and their interrelationship by estimating correlation, path analysis to assess the direct and indirect effect of component character on grain yield of finger millet.

## MATERIALS AND METHODS

Field trialwas conducted in the 2013 and 2014 wet seasons, at the Institute for Agricultural Research, Samaru (N $11.1833^0$, $07.6146^0$ E, 686 m above sea level) in the northern Guinea savanna. The field was previously sown tosorghum and left fallow for one year before the trial in 2013 and 2014.

### *Treatments and Experimental Design*

The treatments consisted of 3 seed rates (3, 6, 9 kg $ha^{-1}$), 2 sowing methods (broadcasting, dibbling) and 3 poultry manure rates at (0, 2.5, 5.0 t $ha^{-1}$, NPK [90 kg N +60 kg $P_2O_5$ + 49.8 kg $K_2O$ $ha^{-1}$]). The experiment was laid out in a split plot design with three replications. A factorial combination of sowing method and poultry manure rate constituted the main plot, while seed rate occupied the subplots.

### *Cultural Practices*

The land was ploughed and harrowed to obtain fine soil tilt; poultry manure was applied two weeks prior to sowing on the $20^{th}$ July, 2013 and $9^{th}$ June, 2014. Seeds were mixed with fine sand at a ratio of 1:4 and sown manually on prepared basins. Dibbling was done at 20 x 10 cm inter and intra-row spacing, respectively. NPK fertilizer at the rate of 90 kg N, 60 kg P and 60 kg K $ha^{-1}$, was applied by broadcasting. The N was applied in two equal split doses; at 3 week after sowing. NPK fertilizer (15-15-15) was used to supply P, K and half of N requirements. The second half dose of N, was top dressed at 6 WAS using urea (46% N). Manual weeding was carried out at 3 and 6 WAS.

All other agronomic practices were carried out as at when due. Harvesting was done on the 12th December, 2013 and 2nd December, 2014, respectively, when the crop has attained a physiological maturity. Harvesting was done by cutting the mature heads with a sharp knife and dried for 3 days before threshing a using pestle and wooden mortar and winnowed to remove the straws, foreign materials and unfilled grains.

### *Data Collection*

Data were recorded on cumulative weed density, cumulative dry weight, plant height, leaf area per plant, number of tillers per plant, crop growth rate, panicle length, number of fingers per plant, productive tiller per plant, 1000 grain weigh, straw yield $ha^{-1}$, panicle yield per hectare and grain yield per hectare.

### *Statistical Analysis*

The magnitude and type of relationship between the various parameters measured was determined using simple correlation analysis (Little and Hills, 1978). The direct and indirect individual contribution of some important growth and yield attributes to grain yield were determined using path coefficient analysis according to Dewey and Lu (1958).

## RESULTS AND DISCUSSION

### Correlation Analysis

The correlation of grain yield, weed growth, crop growth and yield components of finger millet in 2013, 2014 and the two-year means at Samaru are shown in Tables 1, 2 and 3. In 2013 (Table 1),there were positive and highly significant correlations of grain yield with growth and yield characters such as plant height, leaf area plant$^{-1}$, crop growth rate, productive tiller plant$^{-1}$, panicle length, harvest index ,1000-grain weight, straw yield $ha^{-1}$ and panicle yield $ha^{-1}$and a positive significant correlation with number of fingers panicle$^{-1}$. However, grain yield was found to be negatively and highly correlated with cumulative weed dry weight, but not correlated with cumulative weed density. The highest and lowest correlations were recorded between harvest index and grain yield, and between cumulative weed dry weight and panicle yield $ha^{-1}$, respectively,

In 2014 (Table 2), there were positive and highly significant correlations of grain yield withplant height, leaf area plant$^{-1}$, productive tiller plant$^{-1}$, number of fingers panicle$^{-1}$, straw yield $ha^{-1}$, panicle length, harvest index, 1000-grain weight and panicle weight $ha^{-1}$.

The correlation of grain yield with crop growth rate was positive and significant. However, grain yield was not correlated with cumulative weed dry weight and cumulative weed density. The highest correlation was between productive tillersplant$^{-1}$ and grain yield, while the lowest was between cumulative weed density and straw yield $ha^{-1}$. The two-year means (Table 3), showed that grain yield was positively and highly significantly correlated with plant height, leaf area plant$^{-1}$, productive tillers plant$^{-1}$, crop growth rate, number of finger panicle$^{-1}$, panicle length plant$^{-1}$,harvest index, 1000-grain weight, straw yield $ha^{-1}$ and panicle yield $ha^{-1}$. However, the correlation of grain yield and cumulative weed dry weight and cumulative weed density were negative and not significant. The highest correlation was between grain yield and productive tillersplant$^{-1}$ and the lowest was between panicle length and cumulative weed density.

The significant and highly positive correlations of grain yield, growth and yield characters indicates the importance of these characters in net assimilate production and partitioning to grain yield in finger millet. Such consistent and similar trend in all the seasons at both locations shows that those characters are very important yield-contributing characters in finger millet. These traits determine the efficiency in diverting assimilates to grain yield. This result is in conformity with findings of Sarmezy (1987) who reported that yield was correlated positively and significantly with the selected growth parameters of finger millet. However, cumulative weed dry weight and weed density correlated negatively with the yield. This indicates that weed infestation critically reduced grain yield of finger millet due to competition for growth factors such as light, nutrients and moisture. Similarly, Bulus (2002) and Gani (2012) obtained negative correlation of weed dry weight and grain yield in finger millet.

**Direct and indirect effects of growth and yield attributes on grain yield of finger millet**

The direct and indirect effects of different growth and yield component on grain yieldin 2013, 2014 and on the mean are presented in Table 4. In 2013, the number of productive tillers plant$^{-1}$ gave the greatest positive direct effect on grain yield, followed by harvest index, panicle yield ha$^{-1}$, 1000-grain weight and plant height. On the other hand, only panicle length gave a negative direct contribution effect on grain yield.

The greater positive indirect effect on grain yield resulted from the number of productive tillers plant$^{-1}$ via harvest index, followed by harvest index via panicle yield ha$^{-1}$ and productive tillersplant$^{-1}$ via panicle yield. The least indirect positive effect on grain yield resulted from plant height via panicle length. All the indirect effectson grain yield resulting from panicle length were negative.

Similarly, in 2014, the number of productive tillers plant$^{-1}$ had the greatest direct effect on grain yield, followed by harvest index, panicle yield ha$^{-1}$, plant height, straw yield ha$^{-1}$ and panicle length, while 1000-grain weight had the least direct effect on grain yield. The highest indirect effect on grain yield resulted from harvest index via productive tillersplant$^{-1}$. The indirect effect of 1000-grain weight via plant heightmade the least contribution. However, all the indirect effects of 1000-grain weight on grain yield were negative.

With respect to the two-year means, the highest direct effect on grain yield resulted from the number of productive tillers plant$^{-1}$, while the least was from panicle length. The highest mean indirect contribution of grain yield was made by the number of productive tillers via harvest index while the lowest mean contribution resulted from panicle length via plant height.

**Path coefficient and percent contribution**

Table 5 shows the percent contributions of individual growth and yield attributes of finger millet and their mean contributionto grain yield at Samaru in 2013 and 2014.

Generally, the highest individual percent contribution to grain yield resulted from the number of productive tillersplant$^{-1}$, followed by harvest index, panicle yield ha$^{-1}$, straw yield ha$^{-1}$, 1000-grain weight, panicle lengthand plant height. The highest positive mean contribution of two plant characters to grain yield was from harvest index via the number of productive tillersplant$^{-1}$ in 2013, 2014 and the two-year mean. The least mean contribution from two plant characters to grain yield resulted from the number of productive tillers plant$^{-1}$ via panicle length in 2013, harvest index and 1000-grain weight in 2014 and the number of productive tillers plant$^{-1}$ via panicle length in the two-year means. However, the percent contribution unaccounted was higher in 2014, followed by the mean across the years and 2013.

In this study, the highest direct and indirect contributions of productive tillers plant$^{-1}$ and harvest index to grain yield of finger millet, suggests that this crop has efficiency for partitioning dry matter into effective tiller production and grain yield.

This finding is in agreement with the report of several studies Kumar *et al.,* (2014) obtained maximum positive direct effects of productive tillers/plant (2.850), biological yield (1.248), harvest index (0.867), number of fingers/ear (0.404), plant height (0.037), and days to 50% flowering (0.021) to grain yield and Ganapathy*et al.* (2011) who reported that productive tillers per plant and finger length are the important yield-contributing traits in finger millet and therefore appropriate critical emphasis needs be given to productive tillers plant$^{-1}$ and finger length while selecting for grain yield improvement. This finding is supported by that of Sumathi *et al* (2006) who reported that number of productive tillers plant$^{-1}$ was the most important yield-contributing characters and needed to be considered while selecting character in finger millet breeding programme.

## CONCLUSION

Correlation and path analysis revealed that, the traits viz., productive tillers per plant and harvest index are theimportant yield contributing traits therefore due critical emphasis needs be given to these traits selecting for grain yield improvement in finger millet.

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**Table 1:** Matrix of correlation coefficients of grain yield with weed growth, crop growth and yield components in 2013 wet season at Samaru

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.000 | | | | | | | | | | | | |
| 2 | -0.031 | 1.000 | | | | | | | | | | | |
| 3 | -0.323** | -0.301* | 1.000 | | | | | | | | | | |
| 4 | -0.391** | -0.181 | 0.726** | 1.000 | | | | | | | | | |
| 5 | -0.065 | -0.101 | 0.427** | 0.344** | 1.000 | | | | | | | | |
| 6 | -0.080 | -0.004 | 0.457** | 0.258* | 0.556** | 1.000 | | | | | | | |
| 7 | -0.029 | -0.087 | 0.388** | 0.497** | 0.298 | 0.342** | 1.000 | | | | | | |
| 8 | -0.035 | -0.217 | 0.605** | 0.419** | 0.388** | 0.123 | 0.427** | 1.000 | | | | | |
| 9 | -0.384** | -0.201 | 0.254* | 0.601** | 0.590** | 0.420** | 0.271* | 0.370** | 1.000 | | | | |
| 10 | -0.207 | -0.068 | 0.188 | 0.382** | 0.094 | 0.125 | 0.296 | 0.288** | 0.138 | 1.000 | | | |
| 11 | 0.160 | -0.218 | 0.599* | 0.613** | 0.010 | 0.013 | 0.308** | 0.138 | 0.425** | 0.243* | 1.00 | | |
| 12 | -0.432** | -0.101 | 0.701** | 0.668** | 0.380** | 0.381** | 0.211 | 0.605** | 0.875** | 0.125 | 0.7544** | 1.000 | |
| 13 | -0.324** | -0.201 | 0.774** | 0.322** | 0.511** | 0.909** | 0.387* | 0.452** | 0.934** | 0.584** | 0.844** | 0.889** | 1.000 |

Df =n-2= 70 * significant at P ≤ 0.05 ** significant at P ≤ 0.01

1. Cumulative weed dry weight
2. Cumulative weed density
3. Plant Height
4. Leaf Area plant$^{-1}$
5. Crop Growth Rate
6. Productive tillers plant$^{-1}$
7. Number of fingers panicle$^{-1}$
8. Panicle length plant$^{-1}$
9. Harvest Index
10. 1000-grain weight
11. Straw yield ha$^{-1}$
12. Panicle weight ha$^{-1}$
13. Grain yield ha$^{-1}$

**Table 2:** Matrix of correlation coefficients of grain yield with weed growth, crop growth and yield components in 2014 wet season at Samaru.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.000 | | | | | | | | | | | | |
| 2 | 0.529** | 1.000 | | | | | | | | | | | |
| 3 | -0.145 | -0.182 | 1.000 | | | | | | | | | | |
| 4 | -0.107 | -0.099 | 0.546** | 1.000 | | | | | | | | | |
| 5 | -0.201 | -0.197 | 0.566** | 0.217 | 1.000 | | | | | | | | |
| 6 | -.0.278 | -0.250 | 0.150 | 0.549** | 0.685** | 1.000 | | | | | | | |
| 7 | -0.069 | -0.021 | 0.078 | 0.176 | 0.165 | 0.128 | 1.000 | | | | | | |
| 8 | -0.151 | -0.125 | 0.443** | 0.718** | 0.165 | 0.329** | 0.042 | 1.000 | | | | | |
| 9 | -0.116 | 0.109 | 0.404** | 0.801** | 0.132 | 0.540** | 0.138 | 0.665** | 1.000 | | | | |
| 10 | -0.229 | -0.211 | 0.425** | 0.715** | 0.165 | 0.355** | 0.173 | 0.588** | 0.138 | 1.000 | | | |
| 11 | -0.179 | -0.250* | 0.460** | 0.677** | 0.349** | 0.410** | 0.22 | 0.532** | 0.609** | 0.4486** | 1.000 | | |
| 12 | -0.192 | -0.125 | 0.416** | 0.672** | 0.213 | 0.466** | 0.466** | 0.637** | 0.563** | 0.623** | 0.713** | 1.000 | |
| 13 | -0.251 | -0.197 | 0.662** | 0.860** | 0.218* | 0.956** | 0.505** | 0.771** | 0.883** | 0.647** | 0.830** | 0.8092** | 1.000 |

Df =n-2= 70, * significant at P ≤ 0.05, ** significant at P ≤ 0.01

1. Cumulative weed dry weight
2. Cumulative weed density
3. Plant Height
4. Leaf Area plant$^{-1}$
5. Crop Growth Rate
6. Productive of tillers plant$^{-1}$
7. Number of fingers panicle $^{-1}$
8. Panicle length plant$^{-1}$
9. Harvest Index
10. 1000-grain weight
11. Straw yield ha$^{-1}$
12. Panicle weight ha$^{-1}$
13. Grain yield ha$^{-1}$

**Table 3:** Matrix of correlation coefficients of two year means of grain yield with weed growth, crop growth and yield components at Samaru

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.000 | | | | | | | | | | | | |
| 2 | 0.303** | 1.000 | | | | | | | | | | | |
| 3 | -0.051 | -0.144 | 1.000 | | | | | | | | | | |
| 4 | 0.149 | -0.157 | 0.644** | 1.000 | | | | | | | | | |
| 5 | -0.089 | -0.313** | 0.410** | 0.271** | 1.000 | | | | | | | | |
| 6 | 0.070 | -0.422** | 0.422 | 0.255** | 0.468** | 1.000 | | | | | | | |
| 7 | -.0.001 | -0.091 | 0.267** | 0.347** | 0.205* | 0.140 | 1.000 | | | | | | |
| 8 | -0.122 | -0.321** | 0.270** | 0.549** | 0.057 | 0.174 | 0.140 | 1.000 | | | | | |
| 9 | -0.026 | 0.108 | 0.517** | 0.619** | 0.471** | 0.382** | 0.274** | 0.341** | 1.000 | | | | |
| 10 | -0.084 | -0.161 | 0.548** | 0.530** | 0.193* | 0.285** | 0.195* | 0.493** | 0.489** | 1.000 | | | |
| 11 | -0.024 | -0.189* | 0.523** | 0.634** | 0.169* | 0.255** | 0.163 | 0.378** | 0.493** | 0.386** | 1.000 | | |
| 12 | -0.237** | -0.165* | 0.324** | 0.668** | 0.315** | 0.343** | 0.206* | 0.411** | 0.529** | 0.356** | 0.726** | 1.000 | |
| 13 | -0.082 | -0.086 | 0.718** | 0.897** | 0.246** | 0.931** | 0.250** | 0.584** | 0.909** | 0.616** | 0.837** | 0.849** | 1.000 |

Df =n-2= 70 * significant at P ≤ 0.05, ** significant at P ≤ 0.01

1. Cumulative weed dry weigh
2. Cumulative weed density
3. Plant Height
4. Leaf Area plant$^{-1}$
5. Crop Growth Rate
6. Productive tillers plant$^{-1}$
7. Number of fingers panicle$^{-1}$
8. Panicle length plant$^{-1}$
9. Harvest Index
10. 1000-grain weight
11. Straw yield ha$^{-1}$
12. Panicle weight ha$^{-1}$
13. Grain yield ha$^{-1}$

**Table 4:** Direct and indirect contribution of growth and yield components to grain yield in 2013 and 2014 wet seasons and their two year means at Samaru

| Yield Attributes | Effect Through | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Plant Height | Harvest Index | Productive Tillers Plant$^{-1}$ | 1000-Grain Weight | Panicle length Plant$^{-1}$ | Panicle Weight ha$^{-1}$ | Straw Yield ha$^{-1}$ | **Total Correlation** |
| **2013** | | | | | | | | |
| Plant Height | **0.0053** | 0.2061 | 0.2619 | 0.0365 | -0.0059 | 0.1652 | 0.1050 | 0.7749 |
| Harvest Index | 0.0038 | **0.2885** | 0.2597 | 0.0268 | -0.0055 | 0.2243 | 0.1365 | 0.9343 |
| Productive Tillers Plant$^{-1}$ | 0.0043 | 0.2335 | **0.3210** | 0.0466 | -0.0098 | 0.1914 | 0.1218 | 0.9088 |
| 1000-Grain Weight | 0.0019 | 0.1228 | 0.2406 | **0.1065** | -0.0042 | 0.0243 | 0.0417 | 0.5838 |
| Panicle Length | 0.0010 | 0.0524 | 0.2044 | 0.0147 | **-0.0303** | 0.0543 | 0.0236 | 0.4520 |
| Panicle Yield ha$^{-1}$ | 0.0034 | 0.2563 | 0.2437 | 0.0102 | -0.0065 | **0.2525** | 0.1293 | 0.8887 |
| Straw Yield ha$^{-1}$ | 0.0032 | 0.2296 | 0.2278 | 0.0258 | -0.0041 | 0.1904 | **0.1716** | 0.8444 |
| **2014** | | | | | | | | |
| Plant Height | **0.0863** | 0.1072 | 0.3520 | -0.0067 | 0.0071 | 0.0784 | 0.0371 | 0.6615 |
| Harvest Index | 0.0519 | **0.1914** | 0.4838 | -0.0091 | 0.0101 | 0.0971 | 0.0576 | 0.8830 |
| Productive Tillers Plant$^{-1}$ | 0.0484 | 0.1582 | **0.5855** | -0.0096 | 0.0108 | 0.0827 | 0.0446 | 0.9539 |
| 1000-Grain Weight | 0.0410 | 0.1304 | 0.3780 | **-0.0141** | 0.0085 | 0.0705 | 0.0329 | 0.6473 |
| Panicle Length | 0.0423 | 0.1431 | 0.4102 | -0.0082 | **0.0145** | 0.0780 | 0.0360 | 0.7715 |
| Panicle Yield ha$^{-1}$ | 0.0540 | 0.1264 | 0.454 | -0.0079 | 0.0090 | **0.1253** | 0.0482 | 0.8092 |
| Straw Yield ha$^{-1}$ | 0.0474 | 0.1263 | 0.4987 | -0.0068 | 0.0077 | 0.0892 | **0.0677** | 0.8302 |
| **Mean** | | | | | | | | |
| Plant Height | **0.0346** | 0.1567 | 0.3069 | 0.0149 | 0.0006 | 0.1219 | 0.0711 | 0.7183 |
| Harvest Index | 0.0279 | 0.2399 | 0.3713 | 0.0089 | 0.0079 | 0.1608 | 0.0971 | 0.9087 |
| Productive Tillers Plant$^{-1}$ | 0.0264 | **0.1958** | **0.4532** | 0.0186 | 0.0005 | 0.1371 | 0.0833 | 0.9314 |
| 1000-Grain Weight | 0.0215 | 0.0872 | 0.2593 | **0.0462** | 0.0022 | 0.0475 | 0.0373 | 0.6156 |
| Panicle Length | 0.0217 | 0.0977 | 0.2773 | 0.0147 | **-0.0069** | 0.0662 | 0.0298 | 0.5840 |
| Panicle Yield ha$^{-1}$ | 0.0287 | 0.2238 | 0.3489 | 0.0012 | 0.0013 | **0.1890** | 0.0888 | 0.8490 |
| Straw Yield ha$^{-1}$ | 0.0253 | 0.1778 | 0.3633 | 0.0095 | 0.0014 | 0.1399 | **0.1197** | 0.8374 |

**Bold = Direct effect**

**Table 5:** Percentage contribution of different growth and yield attributes of finger millet to grain yield in 2013 and 2014 wet seasons and the two-year means at Samaru

| Treatment | 2013 | 2014 | Mean |
|---|---|---|---|
| **Individual Contribution** | | | |
| Plant Height | 1.00 | 0.75 | 0.88 |
| Harvest Index | 8.82 | 10.67 | 9.75 |
| **Productive Tillers plant$^{-1}$** | **16.56** | **22.28** | **19.42** |
| 1000-Grain Weight | 1.19 | 1.02 | 1.11 |
| Panicle Length | 1.09 | 2.02 | 1.56 |
| Panicle Yield ha$^{-1}$ | 2.24 | 2.57 | 2.41 |
| Straw Yield ha$^{-1}$ | 1.42 | 1.46 | 1.44 |
| **Combined Contribution** | | | |
| Plant Height via Harvest Index | 1.01 | 0.15 | 0.58 |
| Plant Height via Productive Tillers plant$^{-1}$ | 0.06 | 1.85 | 0.96 |
| Plant Height via 1000-Grain Weight | 0.01 | -0.12 | -0.06 |
| Plant Height via Panicle Length plant$^{-1}$ | -0.01 | 0.13 | 0.06 |
| Plant Height via Panicle Yield ha$^{-1}$ | 0.04 | 1.32 | 0.68 |
| Plant Height via Straw Yield ha$^{-1}$ | 0.03 | 0.64 | 0.34 |
| **Harvest Index via Productive Tillers plant$^{-1}$** | **30.70** | **29.52** | **30.11** |
| Harvest Index via 1000-Grain Weight | 1.54 | -1.07 | 0.24 |
| Harvest Index via Panicle Length | -0.31 | 1.20 | 0.45 |
| Harvest Index via Panicle Yield ha$^{-1}$ | 4.40 | 6.40 | 5.40 |
| Harvest Index via Straw Yield ha$^{-1}$ | 5.23 | 2.80 | 4.02 |
| Productive Tillers plant$^{-1}$via 1000-Grain Weight | 3.07 | -0.37 | 1.35 |
| Productive Tillers plant$^{-1}$ via Panicle Length | -0.64 | 0.42 | -0.11 |
| Productive Tillers plant$^{-1}$ via Panicle Yield ha$^{-1}$ | 6.31 | 3.17 | 4.74 |
| Productive Tillers plant$^{-1}$ via Straw Yield ha$^{-1}$ | 4.34 | 1.71 | 3.03 |
| 1000-Grain Weight via Panicle Length | -0.09 | -0.02 | -0.06 |
| 1000-Grain Weight via Panicle Yield ha$^{-1}$ | 0.53 | -0.20 | 0.17 |
| 1000-Grain Weight via Straw Yield ha$^{-1}$ | 0.98 | -0.09 | 0.45 |
| Panicle Length via Panicle Yield ha$^{-1}$ | 0.33 | 0.23 | 0.28 |
| Panicle Length via Straw Yield ha$^{-1}$ | -0.16 | 0.11 | -0.03 |
| Panicle Yield ha$^{-1}$ via Straw Yield ha$^{-1}$ | 1.97 | 1.21 | 1.59 |
| **Residual** | **8.34** | **10.22** | **9.28** |
| Total | 100.00 | 100.00 | 100.00 |