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# Character Association and Path Coefficient Analysis for Yield and its Component Traits in Ridge Gourd [*Luffa acutangula* (L.) Roxb.] Genotypes

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**Abstract**

The present investigation was carried out during *kharif* (July–October, 2025) at the Agricultural Research Station, Kalloli, University of Agricultural Sciences, Dharwad with an aim to assess character association and to determine the direct and indirect effects of yield contributing traits on fruit yield vine$^{-1}$ of twenty seven genotypes of ridge gourd. The results revealed that genotypic correlation and path coefficients were generally higher than their corresponding phenotypic values, indicating minimal environmental influence and strong inherent association among the traits. Correlation analysis showed that fruit yield vine$^{-1}$ was positively and significantly associated with average fruit weight, number of fruits vine$^{-1}$, fruit length and fruit diameter, whereas days to first fruit harvest exhibited a negative association, indicating the advantage of early maturity. Among the yield contributing traits, average fruit weight (0.966) and number of fruits vine$^{-1}$ (0.945) recorded the highest positive genotypic correlations with fruit yield. Path coefficient analysis further revealed that average fruit weight (0.7483) and number of fruits vine$^{-1}$ (0.3414) exerted high positive direct effects on yield along with strong positive correlation, confirming their major role in yield determination. Hence, from the current study it was concluded that number of fruits vine$^{-1}$ and fruit weight were the most important yield contributing traits and selection based on these characters would be effective for improving fruit yield in ridge gourd.

***Keywords:*** Fruit weight, correlation, direct effects, indirect effects

## 1. Introduction

Ridge gourd [*Luffa acutangula* (L.) Roxb.]is an important cucurbitaceous vegetable widely cultivated in tropical and subtropical regions. It is commonly known as turai, turiya, heerekai or beerakai and ridge gourd is alternatively termed as ribbed gourd, angled gourd, angled loofah, Chinese okra, silky gourd or vegetable gourd. The name *Luffa* comes from the commercial product "loofah" that is used for preparing bath sponges, scrubbers, doormats, pillows and mattresses. The fibre is also used as a good insulator. Dried fruits because of their durability can sometimes be utilized for ornamental purposes. The crop is valued for its tender fruits, nutritional, medicinal and economic importance (Thamburaj and Singh, 2005). The crop exhibits considerable variability for growth, flowering and yield traits, which offers ample scope for genetic improvement (Rai et al., 2025; Thulasiram et al., 2023). Ridge gourd occupies a significant place among cucurbitaceous vegetables owing to its wide consumer acceptance, short crop duration and suitability for cultivation under varied production systems. In India, ridge gourd is grown over an area of 24,800 ha, yielding an annual production of 3,16,925 mt. In Karnataka, it covers an area, production and productivity with 3,210 ha, 28,700 mt and 8.94 mt ha$^{-1}$, respectively (Anonymous, 2023). Despite its importance, systematic breeding efforts in ridge gourd are relatively limited compared to other cucurbits. Fruit yield in ridge gourd is a complex quantitative trait governed by several component characters and their interactions with the environment. Selection based solely on yield is often misleading due to the influence of multiple contributing traits and environmental factors. Therefore, understanding the nature and magnitude of association among yield and its component traits is essential for effective selection and crop improvement (Pramod et al., 2025). The existence of substantial genetic variability for growth, flowering, yield and quality traits in ridge gourd has been reported by several researchers, indicating ample scope for genetic improvement through selection and hybridization (Rai et al., 2025; Rani et al., 2023; Thulasiram et al., 2023; Varalakshmi et al., 2015). Correlation analysis is an important statistical tool that provides information on the degree and direction of association between yield and its component traits (Panda et al., 2022). However, correlation alone does not reveal the cause and effect relationship among characters because the observed association may result from indirect influences of other correlated characters. To overcome this limitation, path coefficient analysis is widely employed to partition correlation coefficients into direct and indirect effects. This approach helps identify traits that exert a true influence on yield and therefore deserve greater emphasis during selection (Nisha et al., 2018). Ridge gourd, being a cross pollinated crop, exhibits wide genetic variability, particularly for yield and quality attributes. Efficient utilization of this variability requires a clear understanding of interrelationships among traits. Identification of key yield contributing traits through correlation and path analysis facilitates the development of superior genotypes with improved productivity (Singh and Choudhary, 1977). Although several studies have investigated character association and path coefficients in ridge gourd, information on the interrelationship among growth, earliness and yield traits in diverse germplasm adapted to the northern dry zone of karnataka remains limited. Evaluation of diverse genotypes under local agro climatic conditions is essential for identifying key yield determinants and developing efficient selection strategies for varietal improvement. Hence, the present investigation was undertaken with the following objectives: (i) to assess the character association among growth, earliness, yield and quality traits through genotypic and phenotypic correlation analysis; (ii) to determine the direct and indirect effects of these traits on fruit yield vine$^{-1}$ through path coefficient analysis and (iii) to identify key yield contributing characters that can be effectively utilized as selection criteria for the improvement of fruit yield in ridge gourd.

## 2. Materials and Methods

The present investigation was carried out during *Kharif* (July–October, 2025) at the Agricultural Research Station, Kalloli, University of Agricultural Sciences, Dharwad, located in the Northern dry zone of Karnataka (16.14° N latitude and 74.81° E longitude, at an altitude of 612 m above mean sea level). The experimental material comprised 27 ridge gourd genotypes collected from diverse sources i.e., ICAR-NBPGR, ICAR-IIHR, ICAR-IARI, ICAR-IIVR and local collections, along with one check variety. The experiment was laid out in a Randomized Complete Block Design (RCBD) with two replications. Each genotype was grown at a spacing of 120×90 cm$^2$ with standard agronomic practices recommended by the University of Horticultural Sciences, Bagalkot. Five plants from each genotype in each replication were randomly selected for recording observations on growth, earliness, yield and quality traits.Genotypic and phenotypic correlation coefficients were calculated among all characters following standard procedures as described by Al-Jibouri et al. (1958). The significance of correlation coefficients was tested at 5% and 1% levels. Path coefficient analysis was carried out as per the method suggested (Dewey and Lu, 1959; Wright, 1921) to partition the correlation coefficients into direct and indirect effects, taking fruit yield plant$^{-1}$ as the dependent variable. The residual effect was estimated to indicate the proportion of variation in fruit yield plant$^{-1}$ that was not accounted forthe traits included in the path analysis.

## 3. Results and Discussion

In the present investigation, variance due to treatments (genotypes) was significant for all the traits except for vine length at 30 DAS and primary branches at 30 DAS. In ridge gourd, thirteen traits were analysed for genotypic and phenotypic correlation coefficients.

Correlation coefficient analysis revealed that several growth, earliness and yield component traits exhibited significant associations among themselves at both genotypic and phenotypic levels. Yield contributing traits such as number of fruits vine$^{-1}$, average fruit weight**,** fruitlength and fruit diameter were highly significant and positively associated with each other as well as with fruit yield vine$^{-1}$. Notably, average fruit weight (0.966$^{**}$), number of fruits vine$^{-1}$ (0.945$^{**}$), fruit length (0.783$^{**}$) and fruit diameter (0.698$^{**}$) showed strong positive association with yield at genotypic level (Table 1), indicating that improvement in these characters would simultaneously enhance yield. These results are in agreement with the findings of Choudhary et al. (2014) and Dissanayaka et al. (2023) in ridge gourd.

Among the growth traits, vine length (0.389$^{*}$) showed significant positive association with yield. Similar findings have been reported by Suvedha et al. (2024), while number of primary branches (0.142) exhibited positive but non-significant association (Table 1). These traits were also positively associated with yield components such as fruit length, fruit diameter, fruit weight and number of fruits vine$^{-1}$ (Table 1), suggesting that better vegetative growth supports higher reproductive efficiency and yield formation.

Earliness traits such as days to first male flower opening, days to first female flower opening and days to first fruit harvest were positively associated among themselves, indicating a strong interrelationship among flowering and maturity parameters. However, these traits exhibited negative association with fruit yield vine$^{-1}$, indicating that early flowering and harvesting tend to increase yield (Table 1). Khatoon et al. (2016), Harshitha et al. (2019) and Madhavi et al. (2023) also noticed similar trend in ridge gourd. This suggested that early flowering and early maturity were favourable for higher productivity.

Table 1: Genotypic and phenotypic correlation coefficients among growth, earliness and yield traits in ridge gourd genotypes

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | G | 1 | 0.669** | 0.252* | 0.792** | 0.43** | 0.198* | -0.002 | 0.157 | 0.485** | 0.36* | 0.334* | 0.415** | 0.389** |
| | P | 1 | 0.436** | 0.212* | 0.691** | 0.327* | 0.114 | 0.006 | 0.094 | 0.415** | 0.255* | 0.259* | 0.372** | 0.315* |
| 2 | G | | 1 | 0.643** | 0.715** | 0.735** | 0.684** | -0.366* | 0.667** | 0.275* | 0.055 | 0.124 | 0.132 | 0.142 |
| | P | | 1 | 0.499** | 0.556** | 0.613** | 0.515** | -0.293* | 0.508** | 0.183 | 0.095 | 0.102 | 0.076 | 0.086 |
| 3 | G | | | 1 | 0.525** | 0.883** | 0.638** | -0.115 | 0.643** | 0.193 | -0.215* | -0.015 | -0.122 | -0.028 |
| | P | | | 1 | 0.422** | 0.743** | 0.51** | -0.118 | 0.516** | 0.13 | -0.211* | -0.017 | -0.11 | -0.054 |
| 4 | G | | | | 1 | 0.599** | 0.652** | -0.289* | 0.603** | 0.378** | 0.297* | 0.328* | 0.189 | 0.267* |
| | P | | | | 1 | 0.472** | 0.55** | -0.199* | 0.518** | 0.317* | 0.243* | 0.278* | 0.165 | 0.226* |
| 5 | G | | | | | 1 | 0.78** | -0.165 | 0.77** | 0.113 | -0.146 | -0.044 | -0.122 | -0.066 |
| | P | | | | | 1 | 0.669** | -0.112 | 0.682** | 0.064 | -0.151 | -0.05 | -0.126 | -0.093 |
| 6 | G | | | | | | 1 | -0.515** | 0.999** | -0.103 | -0.184 | -0.161 | -0.339* | -0.267* |
| | P | | | | | | 1 | -0.399** | 0.99** | -0.085 | -0.111 | -0.079 | -0.288* | -0.178 |
| 7 | G | | | | | | | 1 | -0.557** | 0.481** | 0.332* | 0.528** | 0.495** | 0.528** |
| | P | | | | | | | 1 | -0.392** | 0.385** | 0.263* | 0.445** | 0.452** | 0.453** |
| 8 | G | | | | | | | | 1 | -0.175 | -0.211* | -0.213* | -0.42** | -0.331* |
| | P | | | | | | | | 1 | -0.102 | -0.222* | -0.197* | -0.37* | -0.285* |
| 9 | G | | | | | | | | | 1 | 0.574** | 0.797** | 0.666** | 0.783** |
| | P | | | | | | | | | 1 | 0.493** | 0.709** | 0.611** | 0.712** |
| 10 | G | | | | | | | | | | 1 | 0.785** | 0.609** | 0.698** |
| | P | | | | | | | | | | 1 | 0.754** | 0.531** | 0.65** |
| 11 | G | | | | | | | | | | | 1 | 0.837** | 0.966** |
| | P | | | | | | | | | | | 1 | 0.766** | 0.944** |
| 12 | G | | | | | | | | | | | | 1 | 0.945** |
| | P | | | | | | | | | | | | 1 | 0.906** |
| 13 | G | | | | | | | | | | | | | 1 |
| | P | | | | | | | | | | | | | 1 |

*$p<0.05$ and **$p<0.01$ indicate significant at 5% and 1% probability level, respectively; characters: 1: Vine length (m) at 90 DAS; 2: Number of primary branches at 90 DAS; 3: Node at first male flower appearance; 4: Node at first female flower appearance; 5: Days to first male flower opening; 6: Days to first female flower opening; 7: Sex ratio (M:F); 8: Days to first fruit harvest; 9: Fruit length (cm); 10: Fruit diameter (cm); 11: Average fruit weight (g); 12: Number of fruits vine$^{-1}$; 13: Fruit yield vine$^{-1}$ (kg)

Hence, selection for earliness traits should be emphasized while improving yield.

Interestingly, node at first female flower appearance (0.267*) and sex ratio (0.528*) exhibited positive association with yield and yield contributing traits (Table 1). Although from a biological standpoint, early flowering (lower node number) and lower sex ratio are generally considered desirable for higher yield, the positive association observed in the present study may be attributed to their indirect relationship with other growth and yield components such as vine vigour, number of fruits vine$^{-1}$ and fruit weight.

At the phenotypic level, the pattern of association among traits was largely similar to that observed at the genotypic level, although the magnitude of correlation coefficients was generally lower, indicating some influence of environmental factors on trait expression. Correlation analysis revealed that fruit yield vine$^{-1}$ was positively and significantly associated with several important yield contributing traits. Among these, average fruit weight (0.944**), number of fruits vine$^{-1}$ (0.906**), fruit length (0.712**) and fruit diameter (0.650**) exhibited strong positive and highly significant correlations with fruit yield vine$^{-1}$ (Table 1), suggesting that improvement in these traits would result in a corresponding increase in yield. Similar results were reported by Choudhary et al. (2014), Harshitha et al. (2019) and Panda et al. (2022) in ridge gourd.

The strong and positive association among yield contributing traits coupled with their significant correlation with fruit yield suggested that these traits were mutually reinforcing and couldbe effectively utilized in selection programmes for yield improvement. These findings werein agreement with earlier reports of Dubey et al. (2013), Koppad et al. (2016) and Veera et al. (2022).

In the current study, path coefficient analysis was carried out to partition the correlation coefficients into direct and indirect effects of various traits on fruit yield vine$^{-1}$. Both genotypic and phenotypic path analyses were performed. However, greater emphasis was generally given to genotypic path coefficients as they were less influenced by environmental factors than phenotypic path coefficients.

Among the traits studied, average fruit weight (0.7483), number of fruits vine$^{-1}$ (0.3414), node at first female flower appearance (0.1440) and days to first male flower opening (0.2035) exhibited positive direct effects on fruit yield vine$^{-1}$ at genotypic level (Table 2). The similar findings of Koppad et al. (2016) boost the present investigation. Among these, average fruit weight and number of fruits vine$^{-1}$ showed high positive direct effects along with strong positive correlation with yield (0.966$^{**}$ and 0.945$^{**}$), indicating their true and direct contribution towards yield (Table 1). Therefore, direct selection for these traits would be highly effective for yield improvement.

Traits such as fruit length and fruit diameter, although showing strong positive correlation with yield, exhibited low direct effects and contributed mainly through indirect effects via average fruit weight and number of fruits vine$^{-1}$, indicating that their influence on yield was largely mediated through these major yield components (Table 2).

Sex ratio (-0.0588) and days to first fruit harvest (-0.1838) exhibited negative direct effects on yield, even though sex ratio showed significant positive correlation with yield (0.528$^{**}$). This indicated that the positive association of sex ratio with yield wasprimarily due to indirect effects through traits such as average fruit weight (0.3951) and number of fruits vine$^{-1}$ (0.1689). Similarly, days to first fruit harvest contributed negatively to yield directly but exhibited indirect

Table 2: Genotypic and phenotypic path coefficient analysis among yield components in ridge gourd genotypes

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| 1 | G | -0.1413 | 0.0583 | -0.0255 | 0.1140 | 0.0874 | -0.0216 | 0.0001 |
| | P | 0.0293 | -0.0037 | -0.0017 | -0.0284 | -0.0032 | 0.0023 | -0.0003 |
| 2 | G | -0.0946 | 0.0871 | -0.0651 | 0.1030 | 0.1495 | -0.0744 | 0.0215 |
| | P | 0.0128 | -0.0086 | -0.0040 | -0.0228 | -0.0061 | 0.0104 | 0.0135 |
| 3 | G | -0.0356 | 0.0560 | -0.1012 | 0.0757 | 0.1798 | -0.0693 | 0.0067 |
| | P | 0.0062 | -0.0043 | -0.0080 | -0.0173 | -0.0074 | 0.0103 | 0.0055 |
| 4 | G | -0.1119 | 0.0623 | -0.0532 | 0.1440 | 0.1220 | -0.0709 | 0.0170 |
| | P | 0.0203 | -0.0048 | -0.0034 | -0.0410 | -0.0047 | 0.0111 | 0.0092 |
| 5 | G | -0.0607 | 0.0640 | -0.0894 | 0.0863 | 0.2035 | -0.0848 | 0.0097 |
| | P | 0.0096 | -0.0053 | -0.0060 | -0.0194 | -0.0099 | 0.0135 | 0.0052 |
| 6 | G | -0.0280 | 0.0596 | -0.0645 | 0.0939 | 0.1587 | -0.1087 | 0.0303 |
| | P | 0.0033 | -0.0044 | -0.0041 | -0.0225 | -0.0066 | 0.0201 | 0.0184 |
| 7 | G | 0.0003 | -0.0319 | 0.0116 | -0.0417 | -0.0335 | 0.0560 | -0.0588 |
| | P | 0.0002 | 0.0025 | 0.0010 | 0.0082 | 0.0011 | -0.0080 | -0.0462 |
| 8 | G | -0.0234 | 0.0553 | -0.0638 | 0.0908 | 0.1535 | -0.1149 | 0.0328 |
| | P | 0.0048 | -0.0041 | -0.0040 | -0.0227 | -0.0063 | 0.0180 | 0.0184 |
| 9 | G | -0.0685 | 0.0239 | -0.0195 | 0.0544 | 0.0231 | 0.0112 | -0.0283 |
| | P | 0.0122 | -0.0016 | -0.0010 | -0.0130 | -0.0006 | -0.0017 | -0.0178 |
| 10 | G | -0.0509 | 0.0047 | 0.0217 | 0.0428 | -0.0298 | 0.0200 | -0.0195 |
| | P | 0.0075 | -0.0008 | 0.0017 | -0.0100 | 0.0015 | -0.0022 | -0.0122 |
| 11 | G | -0.0473 | 0.0108 | 0.0015 | 0.0472 | -0.0090 | 0.0175 | -0.0310 |
| | P | 0.0076 | -0.0009 | 0.0001 | -0.0114 | 0.0005 | -0.0016 | -0.0206 |
| 12 | G | -0.0586 | 0.0115 | 0.0123 | 0.0272 | -0.0249 | 0.0369 | -0.0291 |
| | P | 0.0109 | -0.0007 | 0.0009 | -0.0068 | 0.0013 | -0.0058 | -0.0209 |

Table 2: Continue...

| | | 8 | 9 | 10 | 11 | 12 | rG/rP |
|---|---|---|---|---|---|---|---|
| 1 | G | -0.0304 | 0.0021 | -0.0460 | 0.2503 | 0.1416 | 0.3893* |
| | P | -0.0028 | 0.0132 | -0.0284 | 0.1836 | 0.1555 | 0.3154* |
| 2 | G | -0.1167 | 0.0012 | -0.0069 | 0.0925 | 0.0451 | 0.1422NS |
| | P | -0.0082 | 0.0058 | -0.0105 | 0.0724 | 0.0319 | 0.0866NS |
| 3 | G | -0.1158 | 0.0008 | 0.0274 | -0.0109 | -0.0415 | -0.028NS |
| | P | -0.0085 | 0.0041 | 0.0234 | -0.0120 | -0.0460 | -0.0541NS |
| 4 | G | -0.1159 | 0.0016 | -0.0379 | 0.2452 | 0.0645 | 0.2668NS |
| | P | -0.0094 | 0.0101 | -0.0270 | 0.1967 | 0.0689 | 0.226NS |
| 5 | G | -0.1387 | 0.0005 | 0.0187 | -0.0332 | -0.0417 | -0.0659NS |
| | P | -0.0109 | 0.0020 | 0.0168 | -0.0358 | -0.0528 | -0.0929NS |
| 6 | G | -0.1944 | -0.0004 | 0.0234 | -0.1205 | -0.1159 | -0.2666NS |
| | P | -0.0153 | -0.0027 | 0.0123 | -0.0562 | -0.1205 | -0.1781NS |
| 7 | G | 0.1024 | 0.0021 | -0.0423 | 0.3951 | 0.1689 | 0.5281** |
| | P | 0.0068 | 0.0122 | -0.0292 | 0.3152 | 0.1889 | 0.4526** |
| 8 | G | -0.1838 | -0.0008 | 0.0268 | -0.1596 | -0.1435 | -0.3306NS |
| | P | -0.0170 | -0.0032 | 0.0247 | -0.1392 | -0.1545 | -0.2853* |
| 9 | G | 0.0323 | 0.0043 | -0.0732 | 0.5961 | 0.2276 | 0.7833** |
| | P | 0.0017 | 0.0317 | -0.0547 | 0.5019 | 0.2552 | 0.7123** |
| 10 | G | 0.0387 | 0.0025 | -0.1275 | 0.5871 | 0.2079 | 0.6977** |
| | P | 0.0038 | 0.0156 | -0.1110 | 0.5343 | 0.2219 | 0.6501** |
| 11 | G | 0.0392 | 0.0034 | -0.1000 | 0.7483 | 0.2857 | 0.9662** |
| | P | 0.0033 | 0.0225 | -0.0837 | 0.7081 | 0.3200 | 0.944** |
| 12 | G | 0.0773 | 0.0029 | -0.0776 | 0.6262 | 0.3414 | 0.9455** |
| | P | 0.0063 | 0.0194 | -0.0589 | 0.5424 | 0.4177 | 0.9058** |

diagonal values indicate direct effects, residual: rG: 0.00422 residual: rP: 0.0218 NS: Non-significant; rG: Genotypic correlation coefficient of fruit yield plant$^{-1}$; rP: Phenotypic correlation coefficient of fruit yield plant$^{-1}$; characters: 1: Vine length (m) at 90 DAS; 2: Number of primary branches at 90 DAS; 3: Node at first male flower appearance; 4: Node at first female flower appearance; 5: days to first male flower opening; 6: Days to first female flower opening; 7: Sex ratio (M:F); 8: Days to first fruit harvest; 9: Fruit length (cm); 10: Fruit diameter (cm); 11: Average fruit weight (g); 12: Number of fruits vine$^{-1}$

effects through other traits.Growth traits such as number of primary branches, node at first male flower appearance and days to first female flower opening exhibited low to moderate direct effects but contributed indirectly through important yield components, indicating their secondary role in yield determination.

The residual effect at genotypic level was very low (0.00422), indicating that the traits included in the analysis explained accounted for almost the entire variability in fruit yield and that the path model was highly reliable. At phenotypic level similar trends were observed, wherein average fruit weight (0.7081) and number of fruits vine$^{-1}$ (0.4177) exhibited high positive direct effects along with strong correlation with yield, confirming their importance in determining yield. Similar findings have been reported by Dubey et al. (2013), Khatoon et al. (2016); Madhavi et al. (2023) and Veera et al. (2022).

## 4. Conclusion

Traits exhibiting high positive correlation along with high direct effects such as average fruit weight and number of fruits vine$^{-1}$wereof prime importance and should be given due emphasis in selection programmes. Thus, it could be concluded that these traits werethe most important yield contributing characters and direct selection based on these traits would be rewarding for improvement of fruit yield in ridge gourd.

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