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Study on Characters Associations and Path Coefficient Analyses for Yield and Yield Components of Cucumber Genotypes (*Cucumis sativus* L.)

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Abstract

Improving fruit yield in cucumber (Cucumis sativus L.) requires a clear understanding of the relationships among yield and its contributing traits. Correlation and path coefficient analyses are widely recognized as effective tools for identifying key characters that influence yield and for guiding selection in crop improvement programmes. This study investigated the associations among yield-related traits in four genetically diverse cucumber genotypes cultivated at the Eastern Research Farm of Michael Okpara University of Agriculture, Umudike, Nigeria. The experiment was conducted using a randomized complete block design with three replications. Data were collected on vegetative growth, flowering behaviour, and fruit characteristics and subsequently analysed using correlation and path coefficient techniques.The correlation analysis showed that fruit yield per hectare was significantly and positively associated with number of leaves (r = 0.766**), fruit length (r = 0.858**), fruit diameter (r = 0.842**), and fruit weight per plant (r = 1.000**), suggesting that improvements in these traits could contribute substantially to higher yield. Path coefficient analysis further revealed that fruit length exerted the highest positive direct effect on fruit yield (0.92), followed by number of leaves (0.14), number of branches (0.13), and number of fruits per plant (0.07). The findings demonstrate that fruit length, number of branches, number of leaves, and number of fruits per plant are important yielddetermining traits in cucumber. These characteristics should therefore be prioritized in breeding and selection programmes aimed at developing high-yielding cucumber cultivars and enhancing cucumber productivity under tropical growing conditions. **Keywords:Correlation Coefficient, Path Coefficient Analysis, Cucumber, Fruit Yield and Yield Components**

Introduction: Cucumber (Cucumis sativus L.) is an economically important fruit crop that has enormous medicinal, nutritional and economic value (Ghimire et al.,2024). It is a member of the Cucurbitaceae family which comprises 118 genera and 825 species. Cucumber (Cucumis sativus L.) is one of the most important and popular vegetable crops grown extensively throughout the tropical and subtropical region of the world. It is a thermophilic and frost susceptible horticultural crop that thrives at temperatures over 20C (Tadkal et al.,2024). It closely resembles the wild form Cucumis hardwicki which is a native of Himalayas and originated in India. Global cucumber production reached 91.2 million metric tons from over 2.2 million hectares, with an average productivity of 40.35 tons per hectare (FAOSTAT,2022). China is the largest cucumber producer worldwide, followed by Turkey, and it accounts for roughly one-third of global output (FAOSTAT,2022). Notably, the top 10 cucumber producing countries contribute 90.54% of the world 's production. With respect to economic importance, cucumber ranks fourth most important vegetable in the world after cabbage ,onion and tomatoes (Ene et al., 2016) . Soft and succulent, the vegetable crop is cherished by man and eaten in salads or sliced into stew in tropical regions. It has enormous health benefits. Cucumber is a very good source of vitamins B and C, potassium, phosphorus, calcium and fibre, (Tadkal et al.,2024). The ascorbic acid and caffeic acid contained in cucumber help to reduce skin irritation (Okonmah, 2011). Sufficient intake of cucumber aids in the prevention of dehydration, increases bone health (Arakelyan, 2019). Kashif, et al. (2008) reported that due to elevated content of potassium (5080mg/100mg), cucumber can be significantly helpful for both high and low blood pressure. Researchers have equally concluded that cucumbers may help control and prevent diabetes, alleviate sunburn and promote healthy hair growth (Srivastava, et al., 2013). Cucumber has been identified as one of the cultivated exotic vegetable crops that has gained popularity in the Northern parts of Nigeria because of its export potential. In Nigeria, cucumber production has not been ranked; it is grown mainly in the northern states especially, in Jos, Plateau State, South-South and a little in the South East. Despite the enormous economic importance of cucumber, farmers still record low yield in the study area due to the non-availability of high- yielding varieties that are well adapted to specific production areas, pest and disease infestation, fertilizer s amongst other factors. Knowledge of the various traits that contribute significantly to yield enhancement will help breeders in selecting and developing high yielding varieties that are well-suited to the study area.

Crop improvement through selection depends not only on fruit yield alone but also depends upon the inter-relationship of number of contributing traits because yield is a complex polygenic character and direct evaluation of this character is difficult. Understanding character associations and conducting path coefficient analysis in cucumber genotypes are crucial for effective yield improvement. Correlation analysis identifies the strength and direction of relationships between yield and its component traits while path coefficient analysis breaks down these correlations to reveal the direct and indirect contributions of each trait to yield (Kumar et al ., 2018). Together, these approaches provide valuable insights for breeders, enabling the selection of specific traits that have the most significant impact on yield, thereby guiding the development of high-yielding cucumber varieties. Adams and Grafius (1971) have mentioned that yield should be considered as end product of a number of traits and breeder should not ignore the principle of balance among these traits. Therefore, the present study was undertaken to assess the nature and magnitude of association among yield and its contributing traits for selecting high yielding genotypes of cucumber .

Materials and Methods : The experiment was conducted at the Eastern Research Farm of Michael Okpara University of Agriculture, Umudike. The site is located within longitude 07o 32E and 05o 29N with altitude of 122m above sea level in the rainforest zone of southern Nigeria. Umudike has rainfall of about 2000-2500mm per annum and annual average temperature of about 26oC. The predominant vegetation is rain forest (NEST,1991). The soil type is classified as sandy loam ultisol (Agboola,1979). The seeds were sourced from Thailand Agro Seed Company Owerri, Imo State, Nigeria.

Genotypes	Origin
CU999	Thailand
Poinsett	North Carolina State University USA
Market more	North Carolina State University USA
Tokyo F1	Japan

Source: Thailand Agro Seed Company Owerri, Nigeria.

The experimental field was slashed, harrowed and the surface brought to fine tilth. The experiment was laid out in a randomized complete block design (RCBD) in three replications . Well rotten poultry droppings at the rate of 15tons/ha dry weight was incorporated into the soil before planting. Seeds were sown using a spacing distance of 1.5m x 1.5m, and 2m between the replicates. Two seeds per hole were planted but later thinned to 1 seedling per stand. Regular weeding of the plot was done as the weeds appeared using hoe. All agronomic procedures were carried. Observations were recorded from three randomly selected plants of each plot in each replication. Data were collected on three selected plants from the centre of the replicate for both vegetative and reproductive traits namely; vine length, number of leaves, leaf area, number of branches, number of female flowers, number of male flowers, days to first female flower initiation, days to first male flower initiation, number of node with first female flower, number of node with first male flower, number of fruits per plant, fruit length, fruit diameter, fruit weight per plant and fruit weight per hectare. Data collected were subjected to statistical analysis for evaluation.

Results and Discussion: Correlation Studies The results obtained from correlation analysis among growth and yield traits of cucumber revealed positive and negative associations among the traits (Table 1.0). Fruit weight per hectare was significantly and positively correlated with number of leaves (r = 0.766**), fruit length (r = 0.858**), fruit diameter (r = 0.842**) and fruit weight per plant (r = 1.000**). Significant and negative correlation was recorded between fruit weight per hectare and days to first female flower initiation (r = -0.947**), days to first male flower initiation (r = -0.918**) and number of fruits per plant (r = -0.825**). Negative correlation was recorded between fruit weight per hectare and number of male flowers (r = -0.179) and number of female flowers (r = -0.294). Fruit length was significant and positively correlated with number of leaves (r = 0.642*), and was positively correlated with vine length (r = 0.375), number of branches (r = 0.521), number of male flowers (r = 0.002) and leaf area (r = 0.136). Significant and negative correlation was recorded between fruit length and days to first female flower initiation (r = -0.846**), days to first male flower initiation (r = -0.859**) and number of fruits per plant (r = -0.761**

Path Coefficient Analysis Path-coefficient analysis was studied considering fruit yield as dependent character. The independent characters were Vine length (VL), Number Branches (NB), Number of Male Flower (NMF), number of female flower (NFF), Leaf area (LA), fruit length (FL), fruit diameter (FD), number of fruit per plant (NOFP) and number of leaves (NL). The correlation was partitioned into direct and indirect effects on fruit yield (figure 4.1). The highest positive and direct effect was found for fruit length (0.92). This was followed by number of leaves (0.14), number of branches (0.13) and number of fruits per plant (0.07). The negative and direct effect was found for vine length (-0.08), number of male flower (-0.38) and number of female flower (- 0.04). The fruit length showed very highly positive indirect effect for fruit yield via fruit diameter (0.88). Similarly, fruit length showed very high positive indirect effect for fruit yield via number of fruits per plant (0.89). Fruit diameter also showed very high positive indirect effect for fruit yield via number of fruit per plant (0.89). Whereas, negative indirect effect was found for fruit yield through number of leaves via number of male flowers (-0.34) and number of branches via number of male flowers (-0.25). Negative indirect effect was also found for fruit yield via vine length and number of male flower (-0.68), via vine length and number of female flowers (-0.70). The direct effect of residual on fruit yield was 0.9 and it represents the number of parameter that were not captured which contributed to the fruit yield.

Discussion: Higher vegetative performance resulted to higher reproductive performance and high fresh fruit yield. Adeniji and Aremu (2007) reported that during flowering and fruit set, the vegetative and reproductive parts could be competing sinks for assimilates. The proportion of assimilates (photosynthates) allocated to the reproductive parts during flowering and fruit set, do go a long way to determine the number of fruitss, weight of fruits, weight, number of seeds and weight of seeds. The accumulation of assimilates is mostly dependent on the vegetative performance of the individual genotypes. The higher the vegetative performance, the higher the assimilates accumulated due to higher photosynthetic activities as well as enhanced activities of the crop roots. The higher the assimilate (photosynthetic), the higher the allocation earmarked for reproductive characters. This explains why high vegetative characters performance resulted to high reproductive characters performance and vice versa.

As it can be seen in Table 1.0, there is a positive and high correlation between fruit weight per hectare and number of leaves (r=0.766**). Also fruit weight per hectare was significantly and positively correlated to fruit length (r = 0.858**), fruit diameter (r = 0.842**) and fruit weight per plant (r = 1.000**). This result indicates that the weight of cucumber fruit increased as the fruit diameter and fruit length increased. Hence, cucumber yield can be subsequently improved with the improvement in these traits. Similar results have been obtained by Ghimire et al., (2024) in fruit weight, fruit length, and fruit circumference. Lnu et al.,(2023) also reported similar findings in fruit weight and fruit length. A positive correlation of fruit weight and fruit length with yield has also been reported by Nandi et al ,(2019). The concept of path coefficient analysis was developed by Wright (Wright 1920). It is a standard partial regression coefficient that assesses the impact of numerous independent characters on a dependent character, both directly and indirectly. Wright (1947) introduced path analysis, a method for identifying yield-contributing traits and, thus, supporting effective indirect selection. Correlation coefficients combined with path coefficients provide more precise information for predicting crop improvement. When the association between yield and a trait arises mainly from the trait's direct effect, direct selection for that trait will enhance yield. Conversely, if the correlation is largely attributable to indirect effects via another component trait, then indirect selection through that intermediate trait will improve yield Veena et al., (2013) and Lnu et al.,(2025). The relatively large and positive direct effects of fruit length, leaf area, number of leaves, number of branches and number of fruit per plant indicated that selection for parents based on these traits would result in increased fruit yield as these traits are directly involved in the high yield of cucumber.. This finding is in agreement with Lnu et al., (2025). Ghimire et al ., (2024) also reported positive and direct effect of number of fruits per plant on yield. The direct effect of number of branches, fruit length and number of fruits per plant were most closely related to fruit yield, indicating that plants producing larger number of branches, fruit length and more number of fruits per plant produced highest fruit yield in cucumber. Sharma et al, (2018), Keshari et al., (2020) recorded similar results .Thus, selection for the parent with more number of branches, fruit length and many number of fruits per plant is a pre-requisite for attaining improvement in fruit yield using the present material and should be given high weightage in any selection process aimed at improving fruit yield in cucumber. The effect of residual factor (0.9) on fruit yield was, suggesting that no other yield components was captured in the analysis and an indication of appropriateness of characters chosen. This was in agreement with Fellahi et al. (2013) who recorded negligible factor on fruit yield.

Conclusion :Correlation results revealed a positive and high correlation between fruit weight per hectare and number of leaves (r=0.766**), fruit length (r = 0.858**), fruit diameter (r = 0.842**) and fruit weight per plant (r = 1.000**). This result indicates that these traits increased the yield of cucumber. Hence, cucumber yield can be subsequently improved with the improvement and selection of these traits. The relatively large and positive direct effects of fruit length, leaf area, number of leaves, number of branches and number of fruit per plant indicated that selection for parents based on these traits would result in increased fruit yield as these traits are directly involved in the high yield of cucumber.Thus, selection for the parent with more number of branches, fruit length and many number of fruits per plant is a pre-requisite for attaining improvement in fruit yield using the present material .

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TRAITS	1	2	3	4	5	6	7	8	9
1).Vine length	1	0.214	-0.096	-0.678*	-0.699*	0.184	-0.449	-0.383	-0.636*
2). N0. of Lvs		1	0.224	-0.344	-0.453	0.438	-0.816**	-.824**	-0.757**
3).No. of braches			1	0.168	-0.056	-0.192	-0.313	-0.413	-0.316
4).No. of male flw				1	0.954**	-0.147	0.275	0.223	0.495
5).No. of female flw					1	-0.102	0.432	0.403	0.646*
6).Lf area						1	-0.386	-0.423	-0.450
7).DFFFI							1	0.984**	0.886**
8).DFMI								1	0.897**
9).No. of fruit/plt									1
10). Fruit length									
11). Fruit diameter									
12).Fruit wt/ plt(kg)									
13).Fruit wt/ha(t/ha)									

FAOSTAT,2022,Food and Agriculture Organization of the United Nations .

Table 1: Pearson correlation matrix of the cucumber parents

ˣCorrelation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed), DFFFI = days to first female flower initiation, DFMI = days to first male flower initiation, fruit wt/ha(t/ha) = fruit weight per hectare, fruit wt/plt(kg) = Fruit weight per plant,

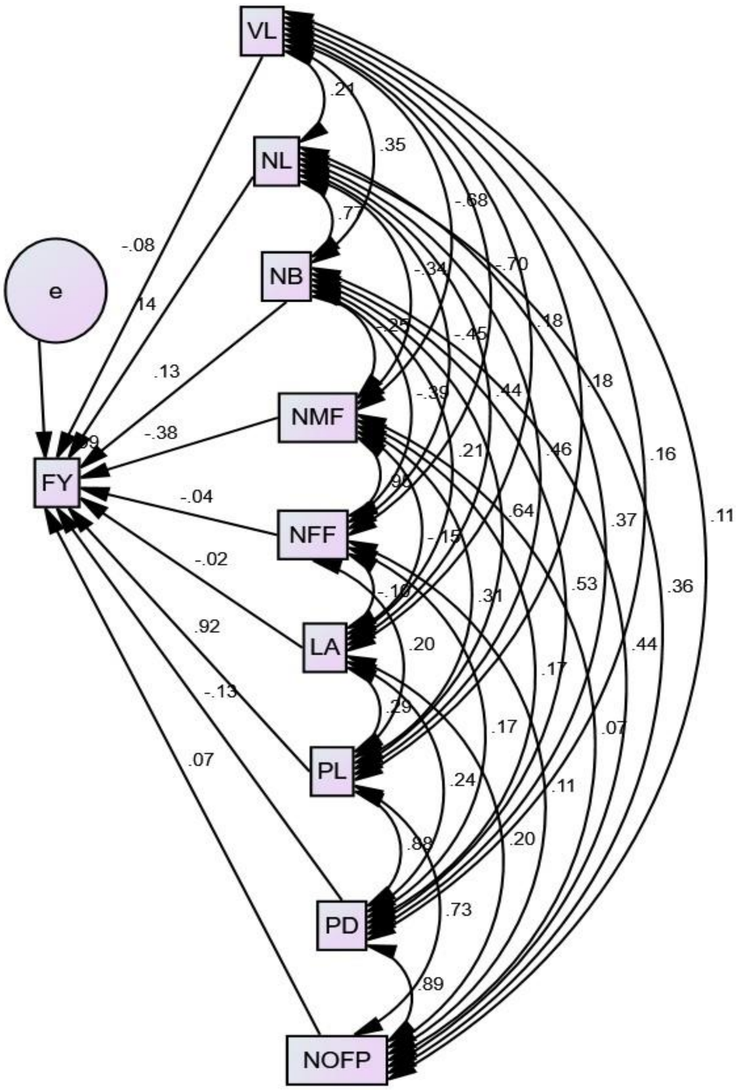

Fig. 1.1: Path diagram and correlation coefficient of nine characters. Single headed arrow denotes direct effect on fruit yield, double headed arrow denotes the correlation coefficients between traits.
Vine length = VL, Number Branches = NB, Number Male Flower = NMF, Number of Female Flower = NFF, Leaf area = LA,Fruit length = FL,Fruit diameter = FD, Number of fruit per plant = NOFP, Number of leaves = NL, e = residual effect.