Evaluation of Genetic Variations and Agronomic Performance of Some Selected Pepper Landraces in Obio Akpa, Akwa Ibom State – Nigeria

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Abstract *- The research was conducted in 2023 at the Teaching and Research Farms of the Faculty of Agriculture, Akwa Ibom State University, Obio Akpa campus, to evaluate the Genetic Variation and Agronomic Performance of some Selected Pepper Land races. The experiment followed a Randomized Complete Block Design (RCBD) with three replications in a split-plot arrangement. Treatments consisted of five pepper varieties: Tatachi, Danjarawa, Yellow Variety, Ayadowo Long Variety and Ayadowo Short Variety. The growth parameters observed were plant height, number of branches per plant, number of flowers per plant, number of fruits per plant, number of seeds per fruit, stem girth, fruits weight and fruit length. Results showed that there was no significant difference in plant height, stem girth, number of branches per plant, number of flowers, and number of fruits per plant among the five varieties. However, there was a significant difference in number of seeds per fruit, weight of fruit and fruit length. The results of the phenotypic and genotypic coefficient of variation shows that genotypic coefficient of variability (PVC) was higher than the genotypic variance and GVC for all the characters, suggesting the influence of the environment in the expression of these characters. Genotypic coefficient of variation was low for plant height (1.55), number of branches per plant (3.67) and moderate for number of flowers per plant (18.53) and was high in number of fruits per plant (38.79). Phenotypic coefficient of variation was low for number of branches per plant (8.54), moderate for plant height (17.69), but high for number of fruits per plant (102.00) and fruit weight per plant (80.15). Among all, Tatachi was the highest performer for all the fruit quality trait which is a signal for genetic variability that could be used for improvement. The least performer was recorded from yellow variety.*

Keywords: *Phenotypic coefficient of variation, Genotypic coefficient of variability, Genotypic variance, Heritability, Genetic Advance.*

I. INTRODUCTION

Pepper, scientifically known as Capsicum spp., is an important horticultural crop cultivated globally for its economic, nutritional, and medicinal value. Belonging to the Solanaceae family, it includes a variety of species such as Capsicum annuum, Capsicum frutescens, and Capsicum chinense, which are widely grown in tropical and subtropical regions. Bosland & Votava, (2012).

Peppers are a major source of vitamins A, C, and E, and contain capsaicin—an active compound with antioxidant, analgesic, and antimicrobial properties (Barboza et al., 2022). In Nigeria and many other countries, pepper plays a crucial role in household diets and income generation for smallholder farmers Olatunji et al., (2022). Its diverse uses, ranging from culinary spice to pharmaceutical applications, make it a valuable crop for both domestic markets and international trade.

Many farmers in Akwa Ibom State still cultivate low yield variety of pepper that are not adapted to their environmental conditions, with regards to this, they are faced with the problem of not knowing the appropriate pepper variety that will suit their environmental conditions, thus this study was conducted to provide farmers with the necessary information regarding agronomic differences and genetic variations that exist among selected land races of pepper variety in order to identify superior genotypes with desirable characteristics which will increase productivity.

II. MATERIAL AND METHOD

2.1 Study Area

The study was carried out at the Teaching and Research Farms, Department of Crop Science, Faculty of Agriculture, Akwa Ibom State University, Obio Akpa Campus, Akwa Ibom State, Nigeria. The area lies between the latitude $4^o31'$ and $5^o30'$ and Longitude $8^o30'$ and $8^o00'$E with an annual rainfall of about 2000 - 2500mm per annum. The rainfall distribution in this area is binomial, with a long rainy

season from April to August and a short dry season from late August to September (usually referred to as the ''August break''). The mean annual temperature ranges between $25 - 27^0C$ and relative humidity is 75 - 79% while the soil type is sandy loam.

2.2 Experimental materials

Five (5) landraces of pepper - Tatachi, Danjarawa, Yellow Variety, Ayadowo Long Variety and Ayadowo Short Variety - were used for the study. The choice of these varieties were based on their acceptability and widespread cultivation in Obio Akpa, Oruk Anam Local Government Area.

2.2.1 Experimental Design and Treatments plot

The experiments were laid out in a Randomized complete Block Design (RCBD) with three (3) replications and five (5) genotypes namely: Tatachi, Ayadowo long variety, yellow variety, Ayadowo short variety and Danyarawa. The total experimental area of land used was 11×20m^2 with individual plot measuring 5×3m^2, with demarcated of 1m pathway between each plot, giving a total plot area of 220m^2. Planting was done in April 2023, bed was made using hand hoe, the seedlings were transplanted after four weeks in the nursery, the planting distance was 60cm×50cm and there were 15 subplots with 25 plants per subplot, giving a total plant population of 375 stands. Weeding was done after three weeks of transplanting and poultry manure was applied to provide nutrients, pepper fruits were harvested after three months of planting, and they were weighed with the aid of scale.

2.3 Data collected and Analysis technique

Data on Agronomic and Yield traits namely: plant height, number of branches per plant, number of flowers per plant, number of fruits per plant, number of seeds per fruits, stem girth, weight of fruits and fruit length were collected. The mean, variances and correlation of the field data were estimated using Analysis of variance (ANOVA) and descriptive statistics. In other to select the best variety of pepper, various variance components of the genotype were also estimated which include: The Phenotypic Coefficients of Variation (PCV), Genotypic Coefficients of Variation (GCV), Phenotypic Variance (δ_p^2), Genotypic Variance (δ_g^2), Heritability (h_b^2), Genetic Advance (GA) and Percentage Mean (GAM), Correlation coefficient (r) defined by:

i. Environmental variance

$$(\delta_e^2) = MS_e = \frac{SS_e}{(t-1)(r-1)} \quad (1)$$

ii. Phenotypic variance

$$(\delta_p^2) = \delta_g^2 + \delta_e^2 \quad (2)$$

iii. Genotypic variance

$$(\delta_g^2) = \frac{MS_g - MS_e}{r} \quad (3)$$

iv. Phenotypic Coefficient of Variance

$$(\text{PCV}) = \frac{\sqrt{\delta_p^2}}{\bar{X}} * 100 \quad (4)$$

v. Genotypic Coefficient of Variance

$$(\text{GCV}) = \frac{\sqrt{\delta_g^2}}{\bar{X}} * 100 \quad (5)$$

vi. Heritability in Broad Sense

$$h_b^2 = \frac{\delta_g^2}{\delta_p^2} * 100 \quad (6)$$

vii. Genetic Advance

$$GA = \frac{K * \sqrt{\delta_p^2 * \delta_g^2}}{\delta_p^2} \quad (7)$$

Where:

$MS_e =$ Mean square error.

$MS_g =$ Mean square Genotype.

$MS_r =$ Mean square Genotype

$r = number\ of\ replicate.$

$\bar{X} =$ Grand mean of a Parameter

Note: field data were analyzed with the aid of SPSS software version 2.0

III. RESULTS AND DISCUSSION

3.1 Agronomic Performance

The mean yield and growth parameters for five pepper varieties are presented in Table 1. The results show no significant difference among the varieties evaluated in all the plant growth and yield characters measured.

Table 1: Means of 5 varieties of pepper in respect of nine (9) growth and yield characters studied

Varieties	Plant Height (cm)	Stem Girth (cm)	Number of Branches	Number of Flowers/ Plants	Number of Fruits/ Plants	Fruit Length (cm)	Number of Seeds/ Fruits	Weight Fresh pod/plant (kg)	Days to 50% Flowering Recorded after Transplanting
Ayadowo long	47.8	6.67	6	17	33	3.3	24	2.0	28
Ayadowo short	42.7	6.47	6	16	34	6.0	43	5.9	30
Tanjarawa	41.1	6.80	7	22	78	7.2	32	3.8	35
Tatachi	48.2	3.42	6	13	34	5.6	43	5.2	45
Yellow	37.8	5.20	6	11	29	6.5	45	6.8	43
Grand Mean	43.5	5.71	6	16	42	5.7	37	4.7	36

Plant Height (cm): Result shows that Tatachi had the highest plant height of 48.2cm while yellow variety recorded the lowest plant height (37.8cm). Tatachi and Ayadowo long variety have values above the grand mean value (43.5cm). Generally, there is no significant difference in the plant height of the different varieties investigated. This could be as a result of the uniformity in the soil condition. Plant height is a quantitative trait which can easily be influenced by the environment (soil type, plant spacing, fertilizer application/soil amendments, rainfall, temperature and seasonal variation (Vijendra, 2005). Homogenous plants can perform differently under different environments due to genotype by environment interaction (G×E). However, the current study shows

Stem Girth (cm): Amongst the varieties, there was no significant difference among the varieties. Tanjarawa had the highest value for stem girth (6.80cm) while Tatachi had the lowest stem girth mean value (3.42cm). Ayadowo long variety, Ayadowo short variety and Tanjarawa mean values exceeded that of the grand means (5.71cm). The size of a stem girth of a plant is determined by various factors chiefly amongst them are: plant spacing, soil nutrient availability, access to sunlight amongst others. All of the above constitute the environmental effects that feature (phenotype) (Daniel *et al.,* 2014). They also further stated that stem girth also determines the yield capacity.

Number of Branches: The result shows that Tanjarawa had the highest number of branches (7). Other varieties recorded average of 6 branches each. It was deduced that there is no significant difference amongst varieties in number of branches. Branching of plant can also be affected by factors like plant spacing, soil fertility status, etc, which ultimately affect the yield. Branch development decreases with increase in plant density and increases branch development in response to increasing land area per plant (Ayudamu *et al.,* 2016).

Number of Flowers/Plant: The study shows that Tanjarawo had the highest flower number (22) as against other varieties. The lowest variety in terms of number of flowers/plants was recorded by yellow variety (11). However, there was no significant difference in number of flower/plant. Number of flowers per plant has significant effect on the yield being the productive part of the plant. According to Chitra and Rajamani, 2010 on the work of Correlation Studies on Yield and its Components in Glory Lily, they found out that number of flower/plants was positively and significantly correlated with yield.

Number of Fruits/Plants: The result did not show significant difference in fruit number/plant among varieties. This reveals that the yield genetic potential of the varieties did not differ under the same environmental conditions. Tanjarawa performed consistently higher virtually in all the economically important traits (Table 2) yet was not significantly different statistically. Yellow variety had the lowest value. It also shows that the number of flowers per plant is positively associated with fruit yield, according to Chitra and Rjamani (2010).

Fruit Length (cm): The results did not show any significant difference in the fruit length, at (P = 0.05%). However, Tanjarawa variety had the highest mean value for fruit length while Ayadowo recorded

the lowest mean value for fruit length. These minimal variations among varieties could be due to their genetic make-up. The consistency in the high performance of Tanjarawa over others shows its genetic superiority.

Number of Seeds/Fruits: There was no significant difference among varieties for number of seeds/fruits. However, yellow variety had the lowest mean value of number of seeds/fruits. In plant breeding programme, it is important to know the number of seeds per plant. Shigeru and Iwao (1978) worked on the relationship between fruit weight and seed content in tomato. The findings of their work revealed strongly and positive genetic correlation between weight and number of seeds/fruits.

Fruit Weight: The results show that there was no significance (P = 0.05%) among varieties evaluated for fruit weight. The varieties with the weightiest fresh fruit/plant were yellow variety while Ayadowo long variety recorded that lowest fruit weight/plant. This is in consonant with Shigeru and Iwao, 1978 findings that fruit weight is determined by number of seeds per fruit (Table 1).

Fruit weight and size are important economic properties in fruit crops, as these determine the market value of such crops produced for commercial purposes.

Days to 50% flowering among the varieties: Among the five varieties studied, Ayadowo long attained 50% flowering in 28 days making it least (best) close followed by Yellow varieties with the record 30 days while Tatachi recorded 45 days which was the longest to attained 50% flowering

3.2. Estimate of genetic variability and heritability of 5 varieties of pepper

The study of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) is not only useful for comparing the relative amount of phenotypic and genotypic variation among different traits but also very useful to estimate the scope for improvement by selection (Bello *et al.,* 2012). The reliability of the parameter to be selected for breeding programme among other factors is dependent on the magnitude of its coefficient of variations (CV) especially (GCV) Bello *et al.,* 2012. The differences between the genotypic and phenotypic coefficients of variation indicate the influence of the environment. However, a lower coefficient of variation (CV) depicts low variability among the tested samples; a proportion of GCV to PCV is highly desirable in breeding work.

The genetic components analysis result is presented in Table 2. The knowledge of the size of genetic variability and heritability in selection of desirable characters could assist the plant breeder in ascertaining criteria to be used for the breeding programme (Bellow *et al.,* 2012).

The results further depicted the phenotypic variance (δ^2P) and phenotypic coefficients of variability (PCV). PCV were higher than the genetic variance (δ^2g) and GCV for all the characters, suggesting some influence of environment in the expression of these characters. Similar results have been reported by Nelson and Somer (1992).

3.2.1 Estimate of Phenotypic and Genetic Coefficient of Variation

Most of the economic characters (e.g., fruit yield) are complex in inheritance and are greatly influenced by several genes interacting with various environmental conditions, Bello *et al.,* (2012).

The Coefficient of variation studied indicated that estimates of Phenotypic Coefficient of Variation (PCV) were higher than the corresponding Genotypic Coefficient of Variation (GCV) for all the growth and yield characters as shown in table 36. This suggested that all the genotypes interacted with the environment to some extent, this corresponds with the findings of Ben (2022) and Bhadru *et al.* (2012) who investigated the agronomic and genetic performance of some yam varieties and rice respectively. The PCV ranged from 8.54% for Number of branched to 102% for Number of fruits/plants. Similarly, GCV ranged from 1.54% for Plant Heights to 38.79% for Number of fruits/plants. According to Deshmukh et al. (1986) PCV and GCV values greater than 20% are regarded as high, whereas values less than 10 percent are considered low and values between 10 percent and 20 percent to be medium. Based on this argument, the combined analysis revealed that Number of branches has low PCV of 8.54%, Plant height has medium PVC of 17.69% while stem grith, Number of flowers, Number of fruits, Fruit Length, Number of seeds and fruit weight recorded high PCV of 34.63%, 37.91%, 102%, 62.1%, 61.09% and 80.15% respectively.

Estimate of GCV was high for Number of fruits (38.79%), Fruit length (30.28%), number of seeds (31.82%) and fruit weight (28.46%); Medium for stem grith (18.53%) and number of flower (16.16%) while plant height and number of branches recorded low GCV of 1.54% and 3.67% respectively.

These results suggest that selection may be effective based on parameters with high or medium PCV and GCV values and their phenotypic expression would be a good indication of genetic potential. These parameters are: stem grith, Number of flowers, Number of fruits, Fruit Length, Number of seeds and fruit weight.

3.2.2 Broad Sense Heritability

The estimates of broad sense heritability act as predictive instrument in expressing the reliability of phenotypic value. Therefore, high heritability helps in effective selection for a particular trait. Heritability is classified as low (below 30%), medium (30-60%) and high (above 60%) as suggested by Johnson *et al.* (1955). From the result, Low magnitude of broad sense heritability estimate was observed in all the traits measured. This implied that selection is impaired for genetic improvement among the varieties evaluated. The plant breeder, therefore, may make his selection safely on the basis of phenotypic expression of these traits in the individual plant by adopting simple selection methods.

Table 2: Estimate of the genotypic components and heritability for 5 varieties of pepper for growth and yield trait

Genetic Components	Plant Height (cm)	Stem Girth (cm)	Number of Branches	Number of Flowers/ Plants	Number of Fruits/ Plants	Fruit length (cm)	Number of Seeds/Fruits	Weight fruit/plant (kg)
Genotypic variance (δ^2 g)	0.45	1.12	0.19	6.69	253.00	2.98	143.13	1.79
Phenotypic variance (δ^2 p)	59.24	3.91	1.03	36.80	1792.00	12.52	527.67	14.19
Environmental variance (δ^2 e)	58.79	2.79	1.23	30.11	2045.00	15.52	670.8	15.98
Genotypic coefficient of variance (GCV)	1.54	18.53	3.67	16.16	38.79	30.28	31.82	28.46
Phenotypic coefficient of variation (PCV)	17.69	34.63	8.54	37.91	102.00	62.10	61.09	80.15
Environmental coefficient of variation (ECV)	17.63	29.25	9.34	34.29	108.97	69.11	68.88	85.05
Broad sense Heritability (HB)	0.76	28.64	12.114	18.18	14.12	23.78	27.12	12.61

3.3 *Analysis of Variance (ANOVA)*

The result of the Analysis of Variance (ANOVA) for the growth and yield parameters of five genotype/varieties of pepper are presented in Table 3 which revealed that there were no significant differences evaluated in growth and yield parameters measured. The major sources of variation in the present study were the varieties and replication at 0.05 level of significance

Table 3: Combined Analysis of Variance (ANOVA) of 5 land races of Pepper in Respect of Eight and Yield Characters.

Sources of Variations	Degree of Freedom	Means sum of Square							
		Plant Height (cm)	Stem Girth (cm)	Number of Branches	Number of Flower/Plant	Number of Fruits	Fruit Length (cm)	Number of Seeds	Weight of Fruit (kg)
Varieties	4	60.14	6.14	0.65	50.19	1265	6.56	241.4	10.61
Replication	2	40.85	1.87	4.74	51.76	2045	7.02	287.8	0.25
Error	8	58.79	2.79	1.23	30.11	2045	15.52	670.8	15.98

At 0.05 level of statistical significance

VI. CONCLUSION

The study investigates the Genetic Variation and agronomic performance of five selected pepper landraces cultivated by farmers in Obio Akpa, Akwa Ibom State in order to identify superior with desirable characteristics which will increase productivity. It was found that there was no significant genotype discrimination. However, Tatachi variety showed superiority and outperformed other studied pepper varieties. Pepper farmers may adopt this variety for cultivation in this study area.

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