



EVALUATION OF THE GENETIC VARIABILITIES OF SOME LEAFY VEGETABLES IN FOREST-SAVANNA TRANSITION ZONE

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ABSTRACT

The study assessed the genetic variability of four leafy vegetable species—Corchorus and Amaranthus spp at the Teaching and Research Farm of Ambrose Alli University, Ekpoma. A Randomised Complete Block Design (RCBD) with three replicates was employed. Data were analysed using Analysis of Variance (ANOVA) to examine genetic parameters such as heritability (H^2), genetic gain (GG), and genetic advance (GA). The results revealed that Amaranthus viridis recorded the highest average values for plant height (17.43 cm, 27.27 cm, 83.87 cm), number of leaves per plant (8.97, 77.00, 193.70), leaf area (154.63 cm², 1501.80 cm², 10,056.20 cm²), and stem girth (0.37 cm, 0.79 cm, 1.50 cm) at 3, 6, and 9 weeks after planting

(WAP). *Corchorus olitorius* had the highest number of branches per plant at 6 and 9 WAP, while *Corchorus tridens* reached 50% flowering and maturity fastest (45 and 58.67 days, respectively). The highest fresh leaf yield (12.61 kg/ha) was recorded in *Amaranthus tricolour*. Traits such as plant height at 9 WAP, leaf area at all stages, stem girth at 6 and 9 WAP, and days to flowering and maturity showed high heritability and genetic advance, indicating strong additive gene effects and potential for improvement through selection. In contrast, stem girth at 3 WAP, fresh leaf weight, and plant height at 3 and 6 WAP showed lower heritability and genetic advance, suggesting influence by non-additive genes and limited responsiveness to selection. Given its superior yield characteristics, *Amaranthus tricolour* is recommended for cultivation in the Ekpoma agroecological zone.

Keywords: Flowering, Fresh Weight, Genetic Advance, Genetic Gain, Heritability, Maturity, Vegetative Characters,

INTRODUCTION

In a plant breeding program, genetic variability is an important consideration. It describes the variations observed within a population. This variability's main components are genotypic and phenotypic variation; important factors include genetic gain, heritability, environmental variation, and related factors. It is widely recognised that genotypes within a species differ in numerous quantitative traits and yield-associated characteristics. However, variance components must be appropriately partitioned to use this genetic variation for crop improvement (Yadav *et al.*, 2016).

The level of genetic diversity in the population significantly affects the effectiveness of a breeding program (Yadav *et al.*, 2016). The main factors influencing a plant's phenotypic expression are its genetic makeup and its interactions with its surroundings. Accordingly, it is essential to use appropriate genetic parameters to separate the observed phenotypic variation into genetic (heritable) and environmental (non-heritable) components (Johnson *et al.*, 2015). A crucial requirement for successful crop improvement is the assessment of genetic variability within a base population, which can be measured using metrics such as the genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) (Swati *et al.*, 2014).

Furthermore, the ratio of genotypic variance to overall phenotypic variance, or heritability, quantifies the proportion of phenotypic variation attributable to genetic factors. According to Allard (1999) and Phani *et al.* (2015), it is a crucial measure of the consistency with which traits are passed down from one generation to the next. Breeders can use heritability estimates to determine whether the observed variation is due to additive genetic effects alone (narrow-sense heritability) or to the entire genetic composition (broad-sense heritability) (Khanorkar and Kathiria, 2010). Genetic advancement, on the other hand, is the expected enhancement of a trait brought about by selection. According to Johnson *et al.* (2015), genetic advancement and heritability are both essential components of effective selection. High genetic advancement and high heritability both point to a dominant role for additive gene action, which increases the effectiveness of selection. On the other hand, low genetic advancement combined with high heritability suggests the presence of non-additive gene effects, which could reduce the efficiency of selection.

High genetic advancement and low heritability suggest that additive gene effects are important but may be obscured by environmental factors, although selection may still be advantageous. Lastly, low genetic advancement and low heritability imply that the trait is primarily influenced by environmental factors, which lessens the efficacy of selection. (Phani *et al.*, 2015; Swati *et al.*, 2014; Johnson *et al.*, 2015). To maximise yield potential, this study aims to evaluate genetic variability among leafy vegetable varieties, with a focus on *Amaranthus* spp. and *Corchorus* spp. Therefore, the objectives of the study were to identify genetic variations, high-yielding varieties and traits that can be improved.

METHODOLOGY

Location of the Experiment

The experiment was conducted at the Teaching and Research Farm of the Faculty of Agriculture, Ambrose Alli University, Emaudo Annexe, Ekpoma. The site is located in Edo State's forest-savanna transition zone, roughly at latitude 6°45' N and longitude 6°08' E.

Materials Employed

Four types of vegetables (*Amaranthus tricolor*, *Amaranthus viridis*, *Corchorus tridens*, and *Corchorus olitorius*) obtained from the National Horticultural Research Institute (NIHORT), Ibadan, were used.

Experimental Design

The treatments (vegetables) were arranged in a Randomised Complete Block Design (RCBD) with three replications. Plots were divided into 12 groups based on treatments after the land was manually cleared with cutlasses. The total land area was 86.4 m², with each plot measuring 1.8 m × 1.8 m. Plots and replicates were separated by a 1 m discard. Nine filled soil bags were placed at 60 cm × 60 cm intervals in each plot, for a total of 108 throughout the experimental field.

Characteristics of Vegetation (growth parameters taken)

- **Plant height:** Three randomly selected plants were measured using a measuring tape from the soil's surface to the plant's tip, and the mean value was recorded.
- **Number of branches per plant:** Three randomly chosen plants per plot had their branches visually counted, and the mean number was noted.
- **Number of leaves per plant:** Three randomly chosen plants' leaves were tallied, and the average number was noted.
- **Leaf area per plant:** Measured from three randomly selected plants in each plot using a measuring tape calibrated in centimetres.

Yield and Yield Components

- **Days to 50 % flowering:** For each of the 16 plots, the amount of time from seeding until half of the plant population flowered was noted, and average values were computed.
- **Days to 50 % maturity:** The average number of days per plot from transplanting to when 50 % of the plant population reached maturity was recorded.
- **Leaf weight per plant:** Three plants per plot were weighed using a sensitive scale, and the average was recorded.

- Leaf Yield per Hectare: The leaf yield per hectare was determined by extrapolating the harvest from each plot.

Data Analysis

Plant growth and yield data were evaluated using Analysis of Variance (ANOVA) at a 5 % significance level. When the F-value indicated statistical significance, mean separation was carried out using the Least Significant Difference (LSD) test.

Genetic Analysis: The genetic analysis focused on agronomic and yield-related characteristics linked to both genotypic and phenotypic expressions. Phenotypic variance was estimated from the treatment mean squares, and genotypic variance was calculated by subtracting the error mean square from the phenotypic variance. These calculations followed the method outlined by Allard (1999).

a. Heritability (H^2):

Broad-sense heritability was computed using the following formula:

$$H_o = \frac{\delta_g^2}{\delta_{ph}^2} \times 100$$

Where; $\delta_g^2 = \text{genotypic variance}$, $\delta_{ph}^2 = \text{phenotypic variance}$

b. Genotypic Advance: This was calculated using the formula:

$$GA = \frac{\delta_g^2}{\delta_{ph}^2} \times k$$

Where; $\delta_g^2 = \text{genotypic variance}$

$\delta_{ph}^2 = \text{square root of phenotypic variance}$

K= [2.06](#) (10% selective index)

Genetic Gain (GG): This was calculated in terms of Genetic Advance (GA) expressed as a percentage of the population mean as follows:

$$GG = \frac{GA}{\bar{X}} \times 100 \quad \text{Where } \bar{X} = \text{Population mean, GA=Genetic Advance}$$

RESULTS

Plant height (cm) of some leafy vegetables

Table 1 illustrates significant varietal differences in leafy vegetable plant height over time, highlighting distinct growth patterns among the four varieties. At 3 weeks after planting (WAP), most varieties exhibit similar early growth, except for *Corchorus olitorius*, which lags behind. By 6 WAP, differences become more evident, with *Corchorus tridens* variety beginning to outpace others. At 9 WAP, *Corchorus tridens* variety shows a marked increase in height, significantly surpassing all others, suggesting it has superior late-stage vegetative growth. In contrast, the other varieties either plateau or grow more slowly, with *Corchorus olitorius* variety consistently showing the least growth. These results indicate that varietal choice strongly influences plant height development, with implications for yield potential and optimal harvest timing in leafy vegetable production.

Table 1: Plant height (cm) of some leafy vegetables

| Varieties | Weeks after planting (WAP) | | |
|----------------------------|----------------------------|---------|--------|
| | 3 | 6 | 9 |
| <i>Amaranthus tricolor</i> | 12.77a | 17.97b | 49.23b |
| <i>Amaranthus viridis</i> | 13.07a | 25.73ab | 35.97b |
| <i>Corchorus tridens</i> | 17.43a | 27.27a | 83.87a |
| <i>Corchorus olitorius</i> | 6.73b | 18.47b | 42.00b |
| LSD (P<0.05) | 4.80 | 8.05 | 15.99 |

Means with same letter(s) indicated in column are not significantly different LSD: Least significant difference

Number of leaves/plant of some leafy vegetables

Table 2 shows that the number of leaves per plant varies by variety and changes as the plants grow. At 3 weeks after planting, all varieties have a similar number of leaves, except *Corchorus*

tridens, which has more. By 6 weeks, *Corchorus tridens* variety continues to lead with the highest leaf count, while the others remain lower. At 9 weeks, *Corchorus tridens* variety still has the most leaves, but *Amaranthus viridis* varieties and *Corchorus olitorius* have caught up somewhat, though not significantly different from each other. *Corchorus olitorius* variety stays lowest throughout. This means that leaf production is strongly influenced by variety, with Variety 3 performing best over time.

Table 2: Number of leaves/plant of some leafy vegetables

| Varieties | Weeks after planting (WAP) | | |
|----------------------------|----------------------------|--------|----------|
| | 3 | 6 | 9 |
| <i>Corchorus olitorius</i> | 6.00b | 37.67b | 91.00b |
| <i>Amaranthus viridis</i> | 6.33b | 53.00b | 128.70ab |
| <i>Corchorus tridens</i> | 8.967a | 77.00a | 193.70a |
| <i>Corchorus olitorius</i> | 6.00b | 42.67b | 138.30ab |
| LSD (P<0.05) | 14.99 | 20.16 | 79.55 |

Means with same letter(s) indicated in column are not significantly different. LSD: Least significant difference

Leaf area per plant of some leafy vegetables

Table 3 shows that leaf area increases over time and varies widely among the leafy vegetable varieties. At 3 weeks after planting, the *Corchorus tridens* variety has the largest leaf area by far, while the *Amaranthus viridis* variety and *Corchorus olitorius* variety have the smallest. By 6 weeks, *Corchorus tridens* variety continues to lead significantly, followed by *Corchorus olitorius* variety, while *Corchorus olitorius* variety and *Amaranthus viridis* variety remain much lower. At 9 weeks, the gap becomes even wider, with *Corchorus tridens* variety showing the largest leaf area overall, *Corchorus olitorius* variety in the middle, and *Corchorus olitorius* and *Amaranthus viridis* Varieties remaining the smallest. This shows that leaf area development

strongly depends on variety, with *Corchorus tridens* being the most vigorous and productive in terms of foliage.

Table 3: Leaf area per plant (cm²) of some leafy vegetables

| Varieties | Weeks after planting | | |
|----------------------------|----------------------|----------|-----------|
| | 3 | 6 | 9 |
| <i>Corchorus olitorius</i> | 74.48b | 689.93c | 2900.40c |
| <i>Amaranthus viridis</i> | 35.10c | 690.15c | 2889.09c |
| <i>Corchorus tridens</i> | 154.63a | 1501.80a | 10056.20a |
| <i>Corchorus olitorius</i> | 32.50c | 1148.07b | 5618.95b |
| LSD (P<0.05) | 5.31 | 13.2 | 15.52 |

Means with same letter(s) indicated in column are not significantly different. LSD: Least significant difference

Stem Girth (cm) of some leafy vegetables

Table 4 shows that stem girth increases with plant growth and varies among the varieties. At 3 weeks after planting, *Corchorus tridens* variety has the thickest stems, while the others are thinner and not significantly different from each other. By 6 weeks, *Corchorus tridens* variety still has the thickest stems, followed by *Corchorus olitorius* variety, with *Corchorus olitorius* and *Amaranthus viridis* having the thinnest. At 9 weeks, *Corchorus tridens* variety remains clearly ahead, with *Corchorus olitorius* variety also showing a strong increase, while *Corchorus olitorius* and *Amaranthus viridis* Varieties lag behind. This indicates that stem thickness is largely influenced by variety, with *Corchorus tridens* variety showing the strongest and most consistent stem development.

Table 4: Stem Girth (cm) of some leafy vegetables

| Varieties | Weeks after planting | | |
|----------------------------|----------------------|---------|-------|
| | 3 | 6 | 9 |
| <i>Corchorus olitorius</i> | 0.26b | 0.4c | 0.51b |
| <i>Amaranthus viridis</i> | 0.17b | 0.36c | 0.62b |
| <i>Corchorus tridens</i> | 0.37a | 0.79a | 1.50a |
| <i>Corchorus olitorius</i> | 0.21b | 0.6233b | 1.18a |
| LSD (P<0.05) | 0.09 | 0.16 | 0.43 |

Means with same letter(s) indicated in column are not significantly different. LSD: Least significant difference

Number of branches per plant of some leafy vegetables

Table 5 shows how the number of branches per plant changes over time for different leafy vegetable varieties. At 3 weeks after planting, no branching is observed in any variety. By 6 weeks, the *Amaranthus viridis* variety stands out with significantly more branches than the others, which show similar, lower numbers. At 9 weeks, the *Amaranthus viridis* variety still leads with the highest number of branches, while the others remain lower and not significantly different from each other. This suggests that branching is strongly affected by variety, with the *Amaranthus viridis* variety having the best branching ability over time.

Days to 50% flowering and maturity, and the fresh weight of some leafy vegetables

Days to 50% flowering did not differ significantly between *Corchorus tridens* and *Corchorus olitorius*. However, *Corchorus tridens* differed significantly from the other varieties in terms of the number of days to 50% maturity (Panda *et al.*, 2017). Early-flowering varieties were also found to mature early. The fresh leaf weight of *Amaranthus viridis* and *Amaranthus tricolor* differed significantly from that of the other varieties (Table 6).

Table 5: Number of branches per plant of some leafy vegetables

| Varieties | Weeks after planting | | |
|----------------------------|----------------------|--------|--------|
| | 3 | 6 | 9 |
| <i>Corchorus olitorius</i> | 0.00 | 10.33b | 22b |
| <i>Amaranthus viridis</i> | 0.00 | 23.33a | 49a |
| <i>Corchorus tridens</i> | 0.00 | 6.67b | 16.67b |
| <i>Corchorus olitorius</i> | 0.00 | 10.67b | 23.33b |
| LSD (P<0.05) | - | 4.45 | 14.67 |

Means with same letter(s) indicated in column are not significantly different. LSD: Least significant difference

Table 6: Days to 50% flowering and maturity and fresh weight of some leafy vegetables

| Varieties | 50% flowering | 50% maturity | Fresh weight (t/ha) |
|----------------------------|---------------|--------------|---------------------|
| <i>Corchorus olitorius</i> | 45c | 58.67c | 8525b |
| <i>Amaranthus viridis</i> | 46.33c | 79.67b | 8528ab |
| <i>Corchorus tridens</i> | 63b | 85.67b | 11097a |
| <i>Corchorus olitorius</i> | 82.33a | 94a | 12613a |
| LSD (P<0.05) | 7.57 | 7.59 | 4.44 |

Means with same letter(s) indicated in column are not significantly different. LSD: Least significant difference

Values of Heritability, Genetic Advance and Genetic Gain

For plant height at 3 WAP, high heritability (94.77%) and genetic advancement (1.95), respectively, were noted. Likewise, for leaf area per plant at 3, 6, and 9 WAP, high heritability

values (96.18%, 93.89%, and 97.93%) and genetic advance (1.98, 1.93, and 2.02) were noted. High heritability (94.45% and 92.08%) and genetic advancement (1.99 and 1.86) were observed in stem girth at 6 and 9 WAP. Furthermore, there was high heritability (96.49% and 90.32%) and genetic advancement (1.99 and 1.89) in the number of branches per plant at 6 and 9 WAP, respectively. Days to 50% flowering showed high genetic advance (2.02) and heritability (98.24%), and days to 50% maturity showed high genetic advance (2.01) and heritability (97.62%).

Table 7: Values of Heritability, Genetic Advance and Genetic Gain

| Character | WAP | PCV | GCV | HO% | GA | GG |
|-------------------------------|-----|----------|----------|-------|------|-------|
| Plant Height | 3 | 57.984 | 51.491 | 88.80 | 1.83 | 41.19 |
| | 6 | 69.91 | 51.63 | 73.85 | 1.52 | 23.04 |
| | 9 | 1377.86 | 1305.77 | 94.77 | 1.95 | 24.73 |
| No of Branches | 6 | 159.194 | 153.611 | 96.49 | 1.99 | 11.20 |
| | 9 | 626.97 | 566.3 | 90.32 | 1.86 | 20.37 |
| Leaf Area | 3 | 208.204 | 200.26 | 96.18 | 1.98 | 18.20 |
| | 6 | 805.24 | 756.1 | 93.89 | 1.93 | 25.71 |
| | 9 | 3275.28 | 3207.33 | 97.93 | 2.02 | 68.82 |
| Stem Girth | 3 | 0.021456 | 0.019214 | 89.55 | 1.84 | 7.53 |
| | 6 | 0.124289 | 0.117264 | 94.35 | 1.94 | 21.61 |
| | 9 | 0.66003 | 0.60774 | 92.08 | 1.91 | 63.77 |
| 50% Flowering | | 916.78 | 900.61 | 98.24 | 2.02 | 15.21 |
| 50% Maturity | | 682.33 | 666.08 | 97.62 | 2.01 | 83.78 |
| Fresh Weight of Leaves | | 38.783 | 32.977 | 85.03 | 1.75 | 36.0 |

PCV: Phenotypic coefficient of variation, GCV: Genotypic coefficient of variation Ho: Heritability, GA: Genetic Advance and GG: Genetic gain

Means with same letter(s) indicated in column are not significantly different. LSD: Least significant difference

DISCUSSION

At three weeks post-planting (WAP), *Amaranthus tricolor*'s plant height differed significantly from that of the other varieties. *Amaranthus tricolor* and *Corchorus tridens* did not significantly differ from one another at 6 WAP, but they did differ from *Corchorus olitorius* and *Amaranthus viridis*. *Amaranthus viridis* differed significantly from the other types at 9 WAP (Table 1). Variations in their genetic composition and environmental conditions may account for the notable differences in plant height observed between the *Amaranthus* and *Corchorus* varieties (Ahmadikhah, 2010).

At 3 and 6 WAP, *Amaranthus viridis* differed significantly from the other types. *Amaranthus tricolor* and *Corchorus olitorius* did not significantly differ from one another at 9 WAP, but they did differ from *Corchorus tridens* (Table 2). *Amaranthus viridis* was found to have more leaves per plant, which is important for photosynthetic activity in crop plants. Significant variations were also observed in the leaf area of *Amaranthus viridis* at 3, 6, and 9 WAP compared with the other varieties (Table 3). Photosynthetic activity increases with increasing leaf area (Ismail *et al.*, 2014). At 3 and 6 WAP, *Amaranthus viridis* was substantially different from the other types in terms of stem girth. *Amaranthus tricolor* and *Amaranthus viridis* did not significantly differ from one another at 9 WAP, but they did differ from the other varieties (Table 4). At 6 and 9 weeks after planting (WAP), *Corchorus olitorius* differed significantly from the other varieties in terms of the number of branches per plant. (Table 5). Days to 50% flowering did not differ significantly between *Corchorus tridens* and *Corchorus olitorius*. However, *Corchorus tridens* differed significantly from the other varieties in terms of the number of days to 50% maturity (Panda *et al.*, 2017). Early-flowering varieties were also found to mature early. The fresh leaf weight of *Amaranthus viridis* and *Amaranthus tricolor* differed significantly from that of the other varieties (Table 6).

For plant height at 3 WAP, high heritability (94.77%) and genetic advancement (1.95), respectively, were noted. Likewise, for leaf area per plant at 3, 6, and 9 WAP, high heritability values (96.18%, 93.89%, and 97.93%) and genetic advance (1.98, 1.93, and 2.02) were noted. High heritability (94.45% and 92.08%) and genetic advancement (1.99 and 1.86) were observed in stem girth at 6 and 9 WAP. Furthermore, there was high heritability (96.49% and 90.32%) and genetic advancement (1.99 and 1.89) in the number of branches per plant at 6 and 9 WAP,

respectively. Days to 50% flowering showed high genetic advance (2.02) and heritability (98.24%), and days to 50% maturity showed high genetic advance (2.02) and heritability (97.62%).

High heritability and genetically advanced traits can be enhanced by selection because they are usually under additive genetic control. According to Johnson *et al.* (2015), a high heritability indicates a significant amount of heritable variation that breeders can effectively exploit. It is more difficult to improve traits with low heritability and genetic advancement because they are typically impacted by environmental factors and non-additive gene effects. Effective breeding programs aiming to enhance agronomic traits require an understanding of the genetic basis and environmental influences on traits (Dias *et al.*, 2011).

CONCLUSION AND RECOMMENDATIONS

This study found notable genetic differences among leafy vegetable varieties, with *Amaranthus viridis* performing best in growth traits like plant height, leaf number, leaf area, and stem girth. Key traits such as plant height at 9 weeks, leaf area at all growth stages, stem girth during mid to late growth, and days to 50% flowering and maturity showed high heritability and genetic advance, suggesting they are mainly controlled by additive genes and can be improved through selection. Meanwhile, *Amaranthus tricolor* produced the highest yield, making it the top choice for immediate cultivation. For breeding, focus on improving traits with high heritability—especially plant height, leaf area, stem girth, and flowering/maturity timing—to develop varieties that combine high yield with strong agronomic traits.

Therefore, it is recommended to:

- Focus breeding programs on *Amaranthus viridis* to enhance its superior growth traits through selection.
- Utilise *Amaranthus tricolor* in production systems aiming for higher yield while incorporating improved traits from *A. viridis* where possible.
- Implement selection strategies targeting traits with demonstrated high heritability and genetic advance for faster genetic gain.
- Conduct further evaluation of genetic variation for other economically important traits to broaden the genetic base for future improvement.

This approach will help develop high-yielding, well-adapted leafy vegetable varieties that meet production goals efficiently.

REFERENCES

- Ahmadikhah, A. (2010). Study on selection effect, genetic advance and genetic parameters in rice. *Annals of Biological Research*, (1): 45-51.
- Allard, R.W. (1999). Principles of Plant Breeding. John Willey and Sons. Inc. New York, USA. 65-70
- Dias J. S. and Ryder E. J. (2011). World vegetable industry: Production, breeding, trends. *Horticulture Reviews* 38: 300-356.
- Ismail, K. S, Sakamoto, T., Hasunuma, T., Zhao, X. Q. and Kondo, A. (2014). Zinc, magnesium, and calcium ion supplementation confers tolerance to acetic acid stress in industrial *Saccharomyces cerevisiae* utilizing xylose. *Biotechnological Journal* 9(12):1519-25
- Johnson, H.W., Robinson, H.F. and Constock, R.E. (2015). Estimate of genetic and environmental variability in soya bean. *Agronomy journal*, 47:314-318
- Khanorkar, S.M. and Kathiria, K. B. (2010). Heterobeltiosis, inbreeding depression and heritability study in okra (*Abelmoschus esculentus* (L.) Moench). *Electronic Journal of plant Breeding*, 1(4): 731-741.
- Meitei, K.M., Bora, G.C., Singh, S.J. and Shiha, A.K. (2014). Morphological based genetic variability analysis and identification of important characters of tomato (*Solanum lycopersicon* L) crop improvement. *American-Eurasian journal of Agriculture and Enviromental Science*. 2014; 14(10):1105-1111.
- Panda, R. K., Mishra, S. P., Nandi, A., Sarkar, S., Pradhan, K., Das, S., Patnaik, A., and Padhiary, A. K. (2017). Genetic variability and varietal performance in vegetable

amaranthus (*Amaranthus* sp.). *Journal of Pharmacognosy and Phytochemistry*, 6(6), 1250–1256.

Phani, K.M., Hameedunnisa, B.A., Manohar, R. and Kumar, N.S. (2015). Estimation of heritability and genetic advance in okra (*Abelmoschus esculentus* L. Moench). *Plant Archives*, 15(1): 489-491.

Swati, B., Reena, N., Meenakshi, R. and Jain, P.K. (2014). Genetic variability in okra (*Abelmoschus esculentus* L. Moench). *An International Quarterly Journal of Environmental Sciences*, 6: 153-156

Yadav R., V. K., Syamal, M.M., Kumar Manish, Pandiyaraj, P., Nagarajukattula and Kaushal, A. (2016). Correlation and path analyses for fruit yield and its component traits in okra (*Abelmoschus esculentus* L. Moench) genotypes. *International Journal of Agriculture Sciences*, 9(13): 4063-4067.