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VARIABILITY, ESTIMATES OF BROAD SENSE HERITABILITY AND GENETIC ADVANCE IN WATERLEAF (*Talinum triangulare* L Walp)

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ABSTRACT

Field experiments were carried out in Umudike and Uyo to access the variability, estimates of heritability and genetic advance in Talinum triangulare. The trial was a factorial experiment laid out in Randomized complete block design, with factor A as seven cultivars of water leaf and factor B as location (Umudike and Uyo). Data were taken on plant height, number of leaves/ plant, number of lateral branches /plant, number of flowers/plant, length of rachis, stem girth, yield/plot, and yield/ha. Analysis of variance of the results from pooled locations showed that the cultivars differed significantly ($p < 0.05$) in plant height, number of leaves/plant, number of lateral branches/plant, number of flowers/plant, length of rachis, leaf weight/ plot and yield/ hectare. Large variability existed within the cultivars in plant height, number of leaves and leaf weight/ plot as shown by genetic component analysis. Plant height, number of leaves/ plant and leaf weight / plot were under the control of additive genes since they had high genotypic coefficient of variation, high broad sense heritability and high genetic advance, hence are heritable. Cultivars with high genotypic coefficient of variation, high broad sense heritability estimates and high genetic advance for plant height, number of leaves/ plant and leaf weight /plot could be selected for improvement of leaf yield in water leaf. However, high genetic gain could be expected from selection for number of leaves/ plant and leaf weight /plot as these traits are much more under the control of additive genes.

Key words: *Talinum triangulare*, Variability, Cultivar, Heritability, Genetic Advance

INTRODUCTION

The genus, Talinum is a herbaceous succulent plant in the Portulacaceae family, and of the Caryophyllales order (Siemonsma and Piluek, 1993) with common name as waterleaf, Ceylon spinach, Florida spinach, Potherb, Fameflower (English), Lagos bologi, Gbure (Yoruba-Nigeria), mmomongikong (Efik/Ibibio-Nigeria), Ngbolodi, Nteoka (Ibo-Nigeria), Cariru, Talina de java (Portuguese), Somchin (Thai), Kumumanu (Papuan-Australia), Grasse' (French) and Krokot (Nya and Eka, 2015). Blessing (2016), Opabode and Adebooye

(2005)r eported that the name waterleaf is due to high moisture content of approximately 90.8g/gm of leaf. Waterleaf is an erect perennial herb that grows up to 80cm in height, it is strongly branched, roots are swollen and fleshy. The leaves are alternate, simple and succulent (Swarna *et al*, 2015 and Oluwale*et al*., 2018). It is one of the most important leaf vegetables among the people of Southern Nigeria (Abiose, 2003). It is rich in Vitamin A, C and minerals, including iron and calcium needed for growth and development for children and pregnant women (Daniel, 2004). It also has medicinal properties (Siemonsma and Piluek,1993),the root is used as tunic for general weakness, possible substitute for ginseng, to treat inflammation and swelling in South East Asia (ACB, 2004). Nigeria has an abundant Talinum germplasm resource. Different species of the genus have been in cultivation for decades especially in Southern Nigeria. Nya and Eka, (2007) reported that the cultivated genus in Nigeria belongs to different species such as *Talinum triangulare* (Jacq.) Willd, *Talinum fruticosum* (L) Juss., *Talinum paniculatum* (Jacq.) Gaertn., *Talinum crassifolium* and *Talinum cuneifolium*. Although the exact origins of these cultivars are still a subject of debate, the varietal

differentiation relies on their inherent genetic variations which could be attributed to their free natural hybridization within and between species. Talinum generally are self pollinated crop, (Nya and Eka, 2007). Its cultivars normally show variations between individuals in the expression of a particular trait. Such variations may arise from the genetic constitution of the individual(s) or due to environmental effects as well as their interactions. Such variability could be exploited through hybridization to raise off-springs with superior qualities. Heritability is a most valuable tool used to estimate the relative degree to which a trait can be transmitted from parents to off-springs, (Idahosa *et al*., 2010, Chinatu*et al*., 2017) and its effect is a measure of genetic association between parents and off-springs, (Memon*et* *al*, 2007 and Idahosa *et al*., 2010). The selection of superior individuals from a created germplasm pool and its utilization to generate superior lines suggests the extent to which improvement is possible (Idahosa *et al*.2010). Broad-sense heritability is the total genetic variation made up of both transmissible (additive genetic) and non-transmissible (non-additive genetic) with interaction effects.

Heritability serves as a guide to the reliability in selection programme (Hamdi, 1992). The determination of heritability is valid only for a particular combination of parents at particular site or season and estimates the magnitude of heritability and other genetic parameters for a trait which would vary from location to location (Idahosa *et al*., 2010). The usefulness of heritability, however, increases not only with genetic advance estimates which shows the magnitude of gain obtained in a trait under a particular selection pressure, but also changes in mean values. The objective of this study is to identify basic traits for selection of cultivars that could be used in hybridization work for the development of high yielding genotypes.

MATERIALS AND METHODS

Seven Waterleaf cultivars as identified by Nya and Eka, (2007), (Broad leaves, Tiny leaves, Curl leaves, Dwarf type, Light Green, Dark-green, and Tall types) were evaluated for yield and yield components in two locations (Umudike, in South-Eastern Nigeria and Uyo, in South - South) in 2019 and 2021. Umudike lies within longitude 070341^{o}E and latitude 050291^{o}N and 122m above sea level (National Root Crop Research Institute, Meteorological Station, Umudike), while Uyo lies within longitude 079128^o E and latitude 050377^o N and 60.96m above sea level (IBOM Airport Station).The experiment was a 7 by 2 factorial laid out in a Randomized Complete Block Design with three replications. Factor A is 7 Cultivars (Broad leaves, Tiny leaves, Curle leaves, Dwarf type, Tall type, Light green and Dark green) while Factor B is 2 locations (Uyo and Umudike)

Agronomic practices such as weeding, supplying and harvesting were carried out manually. Data were collected on plant height, number of leaves, number of branches, number of flowers, length of rachis, stem girth, leaf weight/ plot and yield /hectare.Data were subjected to statistical analysis of variance (ANOVA) using Genstat version 2011 software model. Correlation analysis was carried out to determine the relationship between leaf yield and yield components while Path coefficient analysis was carried out to determine the direct and indirect contributions of each yield component to leaf yield ha^{-1} of the cultivar in each year. Heretabiliy estimates in broad sense (h^2) on mean basis over pooled locations were calculated as suggested by Eckebil*et al*., (1977)

Pooled locations:

$$h^2b(\%) = \frac{\sigma^2 g}{\sigma^2 g + \frac{\sigma^2 g \times \ell}{\ell} + \frac{\sigma^2 e}{r\,\ell}} \text{ X100}$$

Where σ^2g is genetic variance, $\sigma^2e$is error variance, l is location, rl is replicate and location interaction, σ^2g x l is variance due to genotype x location interaction and r is replication.

Genetic advance (GA) and genetic gain (GG) were also calculated to Johnson *et al*., (1955)

Where K= 2.06 (selection differential at 5%) σ^2g = genetic variance, = square root of phenotypic variance. Genetic gain (GG) was determined from genetic variance (GA) expressed as a percentage of the population mean. The experiment was not carried out in 2020 due to Covid pandemic

RESULTS AND DISCUSSION

Results of performances of the cultivars over pooled locations showed significant differences for plant height, number of leaves/ plants, number of lateral branches/plants, number of flowers/ plants, length of rachis, stem girth, yield per plot and yield per hectare in both 2019 and 2021(Tables 1 and 2). Fisher's least Significant Difference (LSD)was used to separate the means of the vegetative characters (plant height, number of leaves/plant and number of lateral branches/ plant) reproductive characters (number of flowers/ plants, length of rachis, stem girth and leaf weight / plot) and yield /ha.

Means of plant height in pooled locations ranged from 8.70 to 31.13cm and from 7.10 to 27.92cm in 2019 and 2021 respectively. From Tables 3 and 4. plant height had positive and strong correlation coefficients of 0.565** and 0.611** with leaf yield^{-1} in 2019 and 2021 respectively. Increase in plant height would lead to increase in leaf yield^{-1}. Tables 5 and 6 showed that plant height was the third most important factor that influenced leaf yield^{-1} in both years. (High broad sense heritability (h^2) of 99.10 in 2019 and 97.22 in 2021were observed for plant height (Tables 7 and 8). This suggests high genetic effects on plant height. Plant height also recorded high genetic advance of 15.43 and 21.14 in 2019 and 2021. with high genetic coefficient of variation of 43.93 in 2019 and 56.37 in 2021 respectively. The slight difference between phenotypic variance and genotypic variance suggested that environmental effect on plant height across locations was minimal. Genetic coefficient of variation (GCV) was by far higher than environmental coefficient of variation (ECV), suggesting that appreciable genetic variation is present in the cultivars. Highbroad sense heritability and high genetic advance confirmed that the trait is controlled by additive gene, hence, is heritable.

From Tables 1 and 2, means of number of leaves/plants in pooled locations ranged from 24.77 to 53.10 and from 22.90 to 46.13 in 2019 and 2021 respectively. From Tables 3 and 4. number of leaves plant^{-1} had positive and strong correlation coefficients of 0.740** and 0.787** with leaf yield^{-1} in 2019 and 2021 respectively. Increase in plant height would lead to increase in leaf yield^{-1}. Tables

5 and 6 showed that plant height was the second most important factor that directly influenced leaf yield^{-1} in both years. High broad sense heritability (h^2) of 78.84% in 2019 and 88.06% in 2021were observed for number of leaves (Tables 7 and 8), suggesting high genetic effects on the trait. Number of leaves/plants also recorded high genetic advance of 20.57 and 26.50 in 2019 and 2021. with high genetic coefficient of variation of 131.5 in 2019 and 188.00 in 2021 respectively. The slight difference between phenotypic variance and genotypic variance suggested that environmental effect on number of leaves/plant across locations was minimal in both years. Genetic coefficient of variation (GCV) was by far higher than environmental coefficient of variation (ECV), suggesting that appreciable genetic variation is present in the cultivars. Highbroad sense heritability and high genetic advance confirmed that the number of leaves/plant is controlled by additive gene.

From tables 1 and 2, means of number of branches/plant in the pooled locations ranged from 2.87 to 7.33 and from 3.10 to 7.87 in 2019 and 2021 respectively. From Tables 3 and 4. Number of branches plant^{-1} had positive and strong correlation coefficients of 0.454* and 0.441* with leaf yield^{-1} in 2019 and 2021 respectively. Increase in number of branches could lead to increase in leaf yield ha^{-1}. Results of Path analysis on Tables 5 and 6 showed that the direct contribution of number of branches to leaf yield ha^{-1}in 2019 and 2021 were minimal, indicating that number of branches should not be a factor of main interest in selection of traits for the improvement of leaf yield. High broad sense heritability (h^2) of 88.28 in 2019 and 88.47% in 2021were observed for number of lateral branches (Tables 7 and 8). This suggests high genetic effects on number of branches. The verylow genetic advance of 4.40 and 4.14 in 2019 and 2021. with low genetic coefficient of variation of 5.168 and 4.666 in 2019 and 2021 respectively recorded for number of branches showed that appreciable genetic variation is not present in the cultivars for improvement of this trait through selection and hybridization.

Means of number of flowers/plant in pooled locations ranged from 8.20 to 24.80 and from 2.70 to 6.90 in 2019 and 2021 respectively, (Tables 1 and 2). From Tables 3 and 4, number of flowers plasnt^{-1} had positive and non- significant ($p>0.05$) correlation coefficients of 0.234 and 0.240 with leaf yield^{-1} in 2019 and 2021 respectively. Effect of increase in number of flowers plant^{-1} on leaf yield ha^{-1} would be negligible. Tables 5 and 6 showed that number of flowers plant^{-1} had minimal direct impact leaf yield ha^{-1} in both years. High broad sense heritability (h^2) of 83.21 in 2019 and 87.38 in 2021were observed for number of flowers (Tables 3 and 4), suggesting high genetic effects on number of flowers. Number of flowers also recorded genetic advance of 7.75 and 12.35 in 2019 and 2021. With high genetic coefficient of variation of 17.00 in 2019 and 41.13 in 2021 respectively. The slight difference between phenotypic variance and genotypic variance suggests that environmental effect on plant height across locations was minimal. Genetic coefficient of variation (GCV) was by far higher than environmental coefficient of variation (ECV), suggesting that appreciable genetic variation is present in the cultivars. Irrespective of the high broad sense heritability, low genetic advance confirmed very low heritable trait with respect to number of flowers

From Tables 1 and 2, means of length of rachis / plant in pooled locations ranged from 3.80to 10.03cm and from 3.43 to 8.93cm in 2019 and 2021 respectively. From Tables 3 and 4. length of rachis had positive and strong correlation coefficients of 0.281 and 0. 267 with leaf yield^{-1} in 2019 and 2021 respectively. Increase in length of rachis would lead to non-significant increase ($P>0.05$) in leaf yield ha^{-1}. Tables 5 and 6 showed that length of rachis did not have direct influence on leaf yield^{-1} in both years. Moderate broad sense heritability (h^2) 45.94% in 2019 and 49.65 in 2021were observed for length of rachis (Tables 7 and 8).suggesting high environmental effects on length of rachis. Length of rachis also recorded low genetic advance of

1.04 and 7.14cm in 2019 and 2021. with low genetic coefficient of variation of 12.23 in 2019 and 13.68 in 2021 respectively. Genetic coefficient of variation (GCV) was almost the same with environmental coefficient of variation (ECV), suggesting low genetic variation is present in the cultivars.

Means of stem girth in pooled locations ranged from 0.20 to 0.51cm and from 0.157 to 0.523cm in 2019 and 2021 respectively (Tables 1 and 2). Stem girth had positive but non-significant ($P>0.05$) correlation coefficients of 0.289 and 0.299 with leaf yield ha^{-1} in 2019 and 2021 respectively. Increase in stem girthmay lead to minimal increase in leaf yield ha^{-1}. Tables 5 and 6 showed that length of rachis had negative direct effect leaf yield ha^{-1} in both years. High broad sense heritability (h^2) of 94.12 in 2019 and 91.67% in 2021were observed for stem girth (Tables 3 and 4), suggesting high genetic effects on plant height. The very low genetic advance of 0.05 and 0.21 in 2019 and 2021, with very low genetic coefficient of variation of 0.016 in 2019 and 0.12 in 2021 respectively, confirmed that the genetic variation is mostly non- heritable. The additive gene effect contributed little to the high broad sense heritability observed for the stem girth.

Means of Leaf weight/ plot in pooled locations ranged from 87.59 to 282.20g and from 65.70 to 141.70g in 2019 and 2021 respectively (Tables 1 and 2). Leaf weight $plot^{-1}$ had positive and significant (P< o0.05) correlation coefficients of 0.947** and 0.946** with leaf yield ha^{-1} in 2019 and 2021 respectively. Increase in Leaf weight $plot^{-1}$ would always lead to increase in leaf yield ha^{-1}. Tables 5 and 6 showed that Leaf weight $plot^{-1}$ was the most important single factor that influenced leaf yield ha^{-1} in both years. High genetic coefficient of variation of 723 in 2019 and 790.6 in 2021 confirmed appreciable genetic variation. High broad sense heritability (h^2) estimates of 81.94% in 2019 and 88.31% in 2021were observed (Tables 7 and 8), suggesting high genetic effects on Leaf yield $plot^{-1}$. The high genetic advance of 22.32 in 2019 and 20.18 in

2021 with high broad sense heritability estimates confirmed that heritable variations do exist in leaf yield plot^{-1} among the cultivars. The slight difference between phenotypic variance and genotypic variance suggests that environmental effect on Leaf weight plot^{-1} across locations was minimal. Esther *et al.,* (2021) had noted that low variation between phenotypic and genotypic estimates may facilitate selection. Genetic coefficient of variation (GCV) was by far higher than environmental coefficient of variation (ECV), suggesting that appreciable genetic variation which is transferable to off-springs is present in the cultivars. The high broad sense heritability estimates and high genetic advance confirmed that Leaf weight plot^{-1} is controlled by additive gene.

Means of yield ha^{-1} in pooled locations ranged from 3851.85 to 7629.60kg and from 2288.90 to 5666.70kg in 2019 and 2021 respectively, (Tables 1 and 2). High broad sense heritability (h^2) of 81.91% in 2019 and 88.28% in 2021were observed for yield/ ha (Tables 7 and 8). This suggests high genetic effects on yield/ha. The moderate genetic advance of 14.30and 11.43 in 2019 and 2021 respectively, with very low genetic coefficient of variation of 0.024 in 2019 and 0.030 in 2021 confirmed that yield/ha should not be selected for the improvement of the cultivars productivity.

The correlation analysis results for yield and yield components in 2019 and 2021, showed that increase in height of the cultivars, number of leaves plot^{-1} and leaf weight plot^{-1} would lead to increase in leaf yield ha$^{-1.}$ Path analysis result revealed that Leaf weight plot^{-1} number of leaves plant^{-1} and plant height were the individual factors that directly influenced leaf yield ha^{-1} suggesting that improvement in these traits may lead to corresponding improvement in yield ha^{-1}. The genotypic coefficient of variability (GCV)was high though slightly lower than phenotypic coefficient of variability (PCV) for plant height, number of leaves/ plant and leaf weight / plot. Appreciable genetic variation existed among the cultivars. The result is similar to the work of Chinatu and

Ukpaka, (2016) who reported that appreciable variation existed among four genotypes of *Piper guineense*. The high broad sense heritability and high genetic advance recorded for plant height, number of leaves/ plant and leaf weight/plot confirmed that the genetic variations are heritable. This implied that plant height, number of leaves and leaf weight/plot were under the control of additive gene effects, hence, the variations can easily be transferred to the offspring through hybridization. Baye, (2002) reported that traits with high heritability values with corresponding high genetic advance often result in variability among crop varieties considered to be products of additive gene effect, Since, improvement efficiency is related to the magnitude of genotypic coefficient of variability, heritability and genetic advance (Johnson *et al.*, 1995), traits with high genetic coefficient of variability, high broad sense heritability and high genetic advance can be improved through selection. Such traits include plant height, number of leaves/plant, and leaf weight/plot. They can be improved by direct selection. This agrees with the findings of Iwo and Ekaette, (2010), Nwofia and Adikibe (2012) in*Ocimumgratissimum*,Chinatu and Ukpaka (2016) in *Piper guineense*, Chinatu*et al*,.(2017) in *Cucumis sativus*

CONCLUSION

High level of variability doexist among the seven cultivars of water leaf especially in plant height, number of leaves/plant and yield/ plot. Plant height, number of leaves plant^{-1} and plant height were the factors that directly determined leaf yield ha^{-1}. Broad sense heritability is a useful tool for measuring the relative importance of additive portion of genetic variance that can be transgressed to the progeny. Progress could be expected from selection between cultivars for plant height, number of leaves and yield/ plot. Moderate progress would be expected for number of branches and number of flower/plant. However, high genetic gain could be expected from selection for number of leaves/ plant and yield/plot as these traits are under the control of additive genes.

Table 1: Mean range value of characters involving seven (7) cultivars of waterleaf (*Talinum triangulare*) in pooled location in 2019

	Plant height	Number of leaves	Number of lateral branches	Number of flowers	Length of ranchis(cm)	Stem girth (cm)	Leaf weight/plot(g)	Yield ha/kg
Average	**17.12**	**38.20**	**4.69**	**15.84**	**6.06**	**0.3726**	**163.8**	**6550.3**
Max	**31.13**	**53.10**	**7.33**	**24.80**	**10.03**	**0.51**	**282.2**	**7629.60**
Min.	**8.70**	**24.77**	**2.67**	**8.20**	**3.80**	**0.20**	**87.59**	**3851.85**
LSD (0.05)	**2.430**	**4.16**	**1.355**	**3.299**	**1.261**	**0.0635**	**20.17**	**320.45**
SE.	**1.182**	**6.47**	**0.826**	**1.852**	**0.613**	**0.0309**	**18.45**	**406.413**

Table 2: Mean range value of character involving seven (7) cultivars of waterleaf (*Talinum triangulare*) in pooled locations in 2021.

	Plant height	**Number of leaves**	**Number of lateral branches**	**Number of flowers**	**Length of ranchis (cm)**	**Stem girth (cm)**	**Leaf weight/ plot(g)**	**Yield ha/kg**
Average	**18.46**	**31.40**	**4.96**	**14.16**	**6.89**	**0.3238**	**92.28**	**3691.01**
Max	**27.92**	**46.13**	**7.87**	**6.90**	**8.93**	**0.523**	**141.70**	**5666.70**
Min.	**7.10**	**22.9**	**3.10**	**2.70**	**3.43**	**0.157**	**65.70**	**2288.90**
LSD (0.05)	**1.425**	**2.31**	**0.828**	**2.09**	**1.239**	**0.0566**	**5.43**	**120.30**
SE.	**1.23**	**2.92**	**0.385**	**2.100**	**1.09**	**0.0274**	**8.54**	**394.51**

Table3 : Person Correlation matrix for leaf yield ha^{-1}and 7 yield components of *T. triangulare* in 2019 cropping season from pooled locations.

PARAMETERS	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1. Plant height	**-**							
2. No. of leaves	**-0.204**	**-**						
3. No. of branches	**-0.134**	**0.931****	**-**					
4. Length of rachis	**0.713****	**0.064**	**0.142**	**-**				
5. No. of flower	**0.430****	**0.536****	**0.623****	**0.716****	**-**			
6. Stem grith	**0.751****	**0.237**	**0.320***	**0.583****	**0.626****	**-**		
7. Leaf weight plot^{-1}	**0.523****	**0.366***	**0.429***	**0.293**	**0.244**	**0.291**	**-**	
8. Leaf yield ha^{-1}	**0.565****	**0.740***	**0.454***	**0.281**	**0.234**	**0.299**	**0.947****	**--**

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at 0.01 level (2-tailed)

Table 4: Person Correlation matrix for leaf yield ha^{-1}and 7 yield components of *T. triangulare* in 2021 cropping season from pooled locations

PARAMETERS	1	2	3	4	5	6	7	8
1. Plant height	**-**							
2. No. of leaves	**-0.225**	**-**						
3. No. of branches	**-0.174**	**0.904****	**-**					
4. Length of rachis	**0.803****	**0.079**	**0.172**	**-**				
5. No. of flower	**0.630****	**0.629****	**0.666****	**0.676****	**-**			
6. Stem grith	**0.677****	**0.253**	**0.337***	**0.566****	**0.654****	**-**		
7. Leaf weight plot^{-1}	**0.605****	**0.387***	**0.422***	**0.279**	**0.217**	**0.295**	**-**	
8. Yield ha^{-1}	**0.611****	**0.787****	**0.441***	**0.267**	**0.240**	**0.289**	**0.946****	**-**

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation significant at 0.01 level (2-tailed)

Table 5: Estimate of direct and indirect effects of six characters on leaf yield of *T. triangulare*in 2019 from pooled locations

TRAITS	Plant height	No. of leaves	No. of branches	Rachis length	No. of flower	Stem Girth	Yield / Plot	Direct effect on yield ha^{-1}
Plant height	**-**							**0.337**
No. of leaves	**-0.212**	**-**						**0.417**
No. of branches	**-0.101**	**0.861**	**-**					**0.083**
Length of Rachis	**0.894**	**-0.111**	**0.015**	**-**				**-0.361**
No. of flower	**0.569**	**0.400**	**0.528**	**0.681**	**-**			**-0.379**
Stem girth	**0.710**	**0.225**	**0.406**	**0.761**	**0.781**	**-**		**-0.495**
Leaf weight/ plot	**0.244**	**0.167**	**0.511**	**0.433**	**0.479**	**0.532**	**-**	**0.755**

Table 6: Estimate of direct and indirect effects of six characters on Leaf yield of *T. triangulare*

TRAITS	Plant height	No. of leaves	No. of branches	Rachis length	No. of flower	Stem Girth	yield / Plot	Direct effect on yield ha-^{1}
Plant height	-							**0.400**
No. of leaves	**-0.317**	-						**0.492**
No. of branches	**-0.85**	**0.914**	-					**0.126**
Length of Rachis	**0.519**	**-0.063**	**0.061**	-				**-0.310**
No. of flower	**0.133**	**0.452**	**0.579**	**0.335**	-			**-0.315**
Stem girth	**0.818**	**0.050**	**0.133**	**0.451**	**0.650**	-		**-0.488**
Leaf weight/ plot	**0.271**	**0.196**	**0.434**	**0.407**	**0.433**	**0.478**	-	**0.677**

ha^{-1} 2021 from pooled locations.

Table 7: Genetic component analysis of variability, broad sense heritability and genetic advance in Waterleaf in 2019

	Mean	P.V.	G.V.	E.V	P.C.V	G.V.C	B.H (%)	G.A	G.G
Plant Height	**17.12**	**57.18**	**56.70**	**0.48**	**44.17**	**43.93**	**99.10**	**15.45**	**90.24**
Number of leaves	**38.2**	**173.4**	**131.5**	**41.9**	**34.47**	**30.02**	**75.84**	**20.57**	**53.85**
Number of branches	**4.69**	**5.854**	**5.168**	**0.686**	**51.59**	**48.47**	**88.28**	**4.40**	**93.82**
Number of flowers	**15.84**	**20.43**	**17.00**	**3.43**	**28.54**	**26.03**	**83.21**	**7.75**	**48.91**
Length of Ranchis	**6.06**	**1.195**	**0.549**	**0.646**	**18.04**	**12.23**	**45.94**	**1.04**	**17.077**
Stem Girth	**0.3726**	**0.017**	**0.016**	**0.001**	**34.99**	**33.95**	**94.12**	**0.05**	**67.85**
Weight/ Plot	**163.8**	**883.0**	**723.0**	**160.0**	**83.80**	**68.66**	**81.94**	**22.32**	**27.42**
Yield	**6550.3**	**3.013**	**2.468**	**0.545**	**0.026**	**0.024**	**81.91**	**11.30**	**30.04**

P.V= phenotypic variance, G.V., Genetic variance, E.V= environmental variance, P.C.V, phenotypic coefficient of variation, GCV, genotypic coefficient of variation, B.H, broad sense heritability, G.A, genetic advance, G.G, genetic gain.

Table 8: Estimation of variability, broad sense heritability and genetic advance in Waterleaf in 2021

	Mean	P.V.	G.V.	E.V	P.C.V	G.V.C	B.H (%)	G.A	G.G
Plant Height	18.46	111.4	108.3	3.1	57.18	56.37	97.22	21.14	114.5
Number of leaves	31.4	213.5	188.0	25.5	46.53	43.67	88.06	26.50	84.41
Number of branches	4.96	5.274	4.666	0.608	46.30	43.55	88.47	4.19	84.38
Number of flowers	14.16	47.07	41.13	5.94	48.45	45.29	87.38	12.35	87.21
Length of Ranchis	6.89	14.29	07.10	07.19	24.87	13.68	49.68	7.14	23.6
Stem Girth	0.3238	0.12	0.011	0.001	33.83	32.39	91.67	0.21	63.88
Weight/ Plot	92.28	895.3	790.6	104.7	32.42	30.47	88.31	20.18	32.06
Yield	3691.01	1.433	1.265	0.168	0.032	0.030	88.28	14.43	48.98

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