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Genetic Variability and Heritability Studies of Desirable Metric Characters in *Talinum triangulare* Land-races in South Eastern Nigeria

¹E.J. Nya and ²M.J. Eka

¹Department of Agronomy,

²College of Crop and Soil Sciences, Michael Okpara University of Agriculture, Umudike,
Umuahia, Nigeria

Abstract: The present study seeks to estimate the genetic variability and heritability of desirable metric characters of *Talinum triangulare* (Jacq.) Willd. Forty two F₁ population of *Talinum triangulare* (Jacq.) Willd were planted in the field at the teaching and research farms of the Michael Okpara University of Agriculture, Umudike, Nigeria and studied for variation and heritability. Variance analysis indicated that phenotypic characters were significant ($p < 0.01$) for such metric characters as final plant height, total number of leaves per plant, leaf area and fresh shoots yield. Partitioning the variance component revealed that the environment showed major effects on the performance of characters like total number of leaves per plant, leaves at flowering, final plant height and basal diameter. While total number of branches per plant and flowering, plant height at flowering, number of days to 50% flowering, leaf area and fresh shoots yield were genetically influenced. Considering the wide variability and high heritability estimates obtained, progress could be expected from selection based on plant height at flowering, number of branches per plant, days to 50% flowering, leaf area and fresh shoots yield.

Key words: *Talinum triangulare* (Jacq.) willd, F₁ population, heritability, phenotypic, genotypic and environmental variability

INTRODUCTION

Although *Talinum triangulare* (Jacq.) Willd is of tropical African origin (Tindall, 1983; Mnzava, 1997) and is dispersed widely throughout African subcontinent and South eastern Nigeria in particular, its breeding is still at its infancy. There is little or no information on the nature and magnitude of genetic variations of various metric characters in *Talinum triangulare* germplasm. Commonly known as water leaf, is a major leaf vegetable among the people of Southern Nigeria (Abiose, 2003) tropical South America (Anderson, 1999; Boose and Holt, 1999) and in most African countries (Rabaihayo, 1994; Okafor *et al.*, 1997). It is used as a good source of essential vitamins and minerals needed for growth and development especially for children and pregnant women (Denton, 1997). It serves to thicken soups and increased the bulk of stews (Daniel, 2004). It is also used for medicinal purposes, where the shoots is used in the preparations of laxatives and curative portions against measles (Akpan, unpublished data). In South East Asia, the roots is used as tonic for general weakness, possible substitute for ginseng, to treat inflammation and swelling (ACB, 2004).

The study of variability and heritability is of primary importance for an efficient breeding program as it provides a basis for effective selections. The types of selection and progress from selection for a particular character depends, in part, on the magnitude of heritability estimates. This is because the expected response under selection is a function of heritability, variation and selection intensity (Ajibade, 2000).

Heritability serves as a guide to the reliability of phenotypic success (Hamdi and Erskine, 1990). The present study was aimed at investigating the genetic variability and heritability estimates of 10 metric characters of *Talinum triangulare*. Such information could be used in breeding programs involving this crop.

MATERIALS AND METHODS

The study was conducted using diallel crosses of 7 land races of *Talinum triangulare* to produce F₁ generation. The 42 resulting genotypes were represented by 280 plants and grown in a Randomized Complete Block Design (RCBD) with 4 replications. Each replicate has 7 experimental units. The entries were planted slantingly at a spacing of 30×30 cm, using one cutting per hole⁻¹. This

gave a total plant population of 111, 111.0 ha⁻¹. Missing stands due to the activities of insect pests were supplied 2 weeks after planting. Cultural practices like hand weeding were done when necessary. The experiment was carried out in the Nigeria agro-ecological zone with latitude 05° 29N and longitude 07° 32E and altitude of 122 m above sea level in the forest zone of South eastern Nigeria, with an average temperature of 30±2°C and mean annual rainfall of 2500-3000 mm (NRCRI, 2001). Atmospheric humidity and precipitation usually exceeding evapotranspiration for more than half of the year (Okafor, 1997).

Observations were made on the following characters, plant height at flowering, final plant height, days to 50% flowering, basal diameter, number of branches at flowering, number of branches per plant, number of leaves at flowering, number of leaves per plant, leaf area and fresh shoots yield. Random sampling method was used in selecting 10 plant stands from each plot for measurement of the various metric characters, at between, 10.00-12.00 am local time. The data were subjected to analysis of variance using the procedure for RCBD as outlined by Steel and Torrie (1980). Duncan's Multiple Range Test (DMRT) was used to separate the means where significant difference existed according to Little and Hills, (1972). Variance components were estimated using the procedure outlined by Uguru (1998). Estimates of broad sense heritability (h²%) was calculated using the formula of Allard (1960) as outlined by Uguru (1998) and obtained as follows:

$$r^2 g / r^2 ph = r^2 g / r^2 e + r^2 ge + r^2 g$$

Where r² g, r² e, r² ph and r² ge are components of variance for genotype, environment, phenotype and interaction, respectively.

RESULTS AND DISCUSSION

The magnitude of the heritability estimates reflects the relative importance of each variance component (Table 1). The result of the variance analysis showed that there were significant differences among the genotypes at p<0.01 (Table 2). Total number of leaves per plant were high in some genotypes, with the highest at P₃₄ (87.83) and its reciprocal 88.66. The lowest number of leaves belonged to P₂₃ (50.82). However, their relative number per Plant was used to determine the genotype yield, as stated in leaf yield. Observation also showed that genotypes (P₃₄) had the highest branch number of 55.50 followed by their reciprocal with 53.25 branches. The number of branches at flowering and per plant were

Table 1: Variance components and broad sense heritability estimates for 10 traits

Morphological characters	Variance components (cm ⁻¹)			
	H _{bs} (%)	r ² ph	r ² g	r ² e
Final plant height	0.35	53.080	18.080	35.00
Plant height at flowering	0.53	16.420	8.670	7.80
Basal diameter	0.41	0.034	0.014	0.02
Total No. branches per plant	0.61	205.050	125.380	79.67
No. branches at flowering	0.18	6.850	0.540	6.31
No. days to 50% flowering	0.96	36.330	33.950	1.38
Total No. leaves per plant	0.12	347.150	41.530	305.62
No. leaves at flowering	0.12	90.310	11.180	79.25
Leaf area	0.72	14356.000	10283.300	4072.70
Fresh shoots yield	0.77	272.050	209.700	62.35

H_{bs} % = Broad sense heritability; r² ph = Phenotypic variance; r² g = Genotypic variance; r² e = Environmental variance

relevant in terms of their contribution to bearing the total number of leaves per plant and consequently in overall shoots yield. Genotype P₃₄ and their reciprocal having 91.30 and 88.00 g respectively, for fresh shoots yield were seen as superior yields. Heritability estimates of 96, 77, 61 and 53% were observed for number of days to 50% flowering, leaf area, fresh shoots yield, number of branches per plant and height at flowering respectively, indicating a good response to selection for these traits. Partitioning the components, also showed high genotypic variance (r² g) for these traits as against a low environmental variance (r² e). To the breeder, selection from among genotypes for these traits will produce materials with similar characters, seeing that they have an additive genetic basis in the population. This is also the reason for the high phenotypic variations in some of the traits which may be due, in part, to the additive effect of alleles conveying such traits in question and, or changes in allele frequencies within the population over generational time. This is useful in determining the proportion of the total phenotypic variance that could be explored during selection of superior traits. In essence, pronounced progress would be expected from selection among genotypes for numbers of days to 50% flowering, leaf area, fresh shoots yield, number of branches per plant and plant height at flowering. Thus the degree of resemblance between one generation and another would be high.

Characters such as final plant height, basal diameter, number of branches at flowering, number of leaves at Flowering and number of leaves per plant had heritability estimates ranging from 12 to 35% indicating that these traits are moderately heritable and selection for these would have to be done several times over many generations of inbreeding to accumulate the desired genes (Table 3). This is because heritability estimates for yield parameters increases with recurrent selections (Betran and Haullauer, 2001). Environments plays a major

Table 2: Mean value for Morphological characters of F₁ hybrids population of *Talinum triangulare* studied

Treatments F ₁ hybrids	Height at flowering (cm)	Final plant height (cm)	Basal diameter (cm)	No. of branches per plant	Days to 50% flowering	No. of leaves per plant	No. of leaves at flowering	No. of branches at flowering	Leaf area (sq cm)	Fresh shoots yield (g)
P ₁₂	19.75 ^d	33.93 ^a	0.93	31.50 ^e	28 ^a	59.50	30.50 ^b	4.00 ^a	639.25 ^b	62.5 ^b
P ₁₃	18.40 ^{ef}	25.03 ^{cd}	0.87	45.50 ^b	21 ^c	70.75 ^b	26.25 ^{bc}	5.50 ^c	873.70 ^a	58.5 ^b
P ₁₄	26.05 ^a	30.03 ^b	0.97	29.25 ^f	23 ^{bc}	67.80 ^d	25.05 ^{bc}	4.10 ^d	552.70 ^d	35.5 ^a
P ₁₅	18.00 ^{ef}	25.00 ^{cd}	0.85	27.40 ^g	24 ^{bc}	65.40 ^d	30.40 ^b	6.70 ^b	660.10 ^c	60.5 ^b
P ₁₆	17.40 ^f	25.02 ^{cd}	0.85	14.75 ⁱ	23 ^{bc}	50.70 ^e	30.10 ^b	6.90 ^b	422.10 ^f	61.0 ^b
P ₁₇	17.50 ^f	25.03 ^{cd}	0.83	15.02 ⁱ	24 ^{bc}	50.00 ^e	25.00 ^{bc}	8.10 ^a	452.20 ^f	62.0 ^b
P ₂₁	18.35 ^{ef}	30.43 ^b	0.92	28.75 ^f	29 ^a	50.75 ^e	37.63 ^a	5.00 ^c	707.50 ^b	57.8 ^c
P ₂₃	18.00 ^{ef}	23.40 ^d	0.93	27.45 ^g	28 ^a	50.82 ^e	15.48 ^d	5.70 ^{cd}	421.70 ^f	44.5 ^{cd}
P ₂₄	14.90 ^h	25.08 ^{cd}	0.65	14.75 ⁱ	29 ^a	65.50 ^d	27.28 ^{bc}	4.00 ^d	461.75 ^f	5.8 ^{cd}
P ₂₅	18.51 ^e	23.41 ^d	0.95	32.00 ^e	28 ^a	60.80 ^d	38.10 ^a	5.00 ^c	546.10 ^d	67.0 ^b
P ₂₆	17.45 ^f	23.43 ^d	0.55	18.00 ^j	28 ^a	70.80 ^d	37.65 ^a	7.80 ^{ab}	561.20 ^d	45.0 ^{cd}
P ₂₇	18.00 ^{ef}	25.04 ^{cd}	0.60	29.01 ^f	26 ^{ab}	59.70 ^e	37.60 ^a	3.60 ^e	456.30 ^f	68.0 ^b
P ₃₁	20.75 ^c	29.85 ^b	0.63	42.75 ^d	24 ^{bc}	59.80 ^e	32.00 ^{ab}	3.50 ^e	799.20 ^a	49.0 ^{cd}
P ₃₂	17.50 ^f	24.70 ^{cd}	0.81	32.15 ^e	24 ^{bc}	65.50 ^d	21.75 ^{cd}	4.60 ^d	745.00 ^a	36.3 ^e
P ₃₄	18.50 ^e	26.25 ^c	0.83	55.50 ^a	23 ^{bc}	87.83 ^a	30.00 ^b	4.50 ^d	783.70 ^a	91.30 ^a
P ₃₅	18.30 ^{ef}	23.40 ^d	0.90	42.00 ^d	24 ^{bc}	50.00 ^e	31.70 ^{ab}	6.50 ^b	680.20 ^b	56.0 ^c
P ₃₆	18.51 ^e	24.70 ^{cd}	0.90	14.70 ⁱ	26 ^{ab}	50.60 ^e	30.00 ^b	5.70 ^{cd}	675.60 ^b	57.1 ^c
P ₃₇	17.45 ^f	25.00 ^{cd}	0.80	27.40 ^g	24 ^{bc}	65.40 ^d	21.00 ^{cd}	5.60 ^{bc}	678.10 ^b	58.2 ^c
P ₄₁	20.50 ^{cd}	23.88 ^d	0.95	24.75 ^h	28 ^a	75.00 ^{ab}	30.00 ^b	7.30 ^{ab}	674.50 ^b	37.0 ^d
P ₄₂	16.00 ^g	34.25 ^a	0.97	18.50 ^j	26 ^{ab}	76.10 ^{ab}	30.50 ^b	5.50 ^{cd}	54.70 ^e	41.0 ^{cd}
P ₄₃	24.75 ^b	29.75 ^b	0.65	53.25 ^a	23 ^{bc}	88.66 ^a	30.75 ^b	7.90 ^{ab}	684.5 ^f	88.0 ^a
P ₄₅	14.91 ^h	25.07 ^{cd}	0.80	32.01 ^e	23 ^{bc}	50.00 ^e	16.45 ^d	6.30 ^d	705.0 ^b	41.5 ^{cd}
P ₄₆	14.90 ^h	23.40 ^d	0.77	29.00 ^f	24 ^{bc}	50.80 ^e	16.40 ^d	6.00 ^{cd}	703.50 ^b	40.0 ^{cd}
P ₄₇	16.01 ^g	23.80 ^d	0.80	27.40 ^g	24 ^{bc}	65.50 ^d	20.60 ^{cd}	6.20 ^{cd}	730.1 ^b	36.0 ^d
P ₅₁	17.40 ^f	25.01 ^{cd}	0.65	27.00 ^g	25 ^{ab}	64.50 ^d	21.10 ^{cd}	4.00 ^d	430.0 ^f	44.6 ^{cd}
P ₅₂	17.42 ^f	23.60 ^d	0.70	32.20 ^e	25 ^{ab}	63.00 ^d	15.50 ^d	5.00 ^c	420.0 ^f	57.1 ^c
P ₅₃	14.81 ^h	23.36 ^d	0.68	40.90 ^d	25 ^{ab}	50.70 ^e	16.70 ^d	3.60 ^e	432.1 ^f	65.1 ^b
P ₅₄	18.41 ^e	25.00 ^{cd}	0.71	32.00 ^e	25 ^{ab}	50.80 ^e	16.40 ^d	3.00 ^e	460.2 ^f	58.0 ^c
P ₅₆	13.90 ^h	23.40 ^d	0.65	18.00 ^j	25 ^{ab}	59.70 ^e	26.20 ^{bc}	4.00 ^d	455.3 ^f	68.0 ^b
P ₅₇	14.80 ^h	23.82 ^d	0.80	27.40 ^g	25 ^{ab}	58.90 ^e	6.400 ^d	5.70 ^{cd}	545.4 ^d	56.0 ^c
P ₆₁	16.01 ^g	25.00 ^{cd}	0.88	14.70 ⁱ	26 ^{ab}	70.50 ^b	26.20 ^{bc}	4.10 ^d	641.2 ^e	58.0 ^c
P ₆₂	17.52 ^f	23.40 ^d	0.82	18.05 ^j	25 ^{ab}	70.61 ^b	25.50 ^{bc}	5.50 ^{cd}	652.3 ^c	58.0 ^c
P ₆₃	14.80 ^h	24.71 ^{cd}	0.70	29.01 ^f	26 ^{ab}	65.70 ^d	25.60 ^{bc}	5.00 ^c	632.1 ^c	67.0 ^b
P ₆₄	8.40 ^{ef}	24.00 ^{cd}	0.65	29.00 ^f	24 ^{bc}	50.00 ^e	26.10 ^{bc}	6.50 ^b	640.2 ^e	56.1 ^c
P ₆₅	14.93 ^h	23.40 ^d	0.67	27.40 ^g	23 ^{bc}	54.00 ^e	25.40 ^{bc}	6.70 ^{ab}	547.0 ^d	58.0 ^c
P ₆₇	16.05 ^g	23.80 ^d	0.80	27.45 ^g	25 ^{ab}	67.70 ^d	26.05 ^{bc}	5.70 ^{cd}	545.0 ^d	49.0 ^{cd}
P ₇₁	17.40 ^f	25.00 ^{cd}	0.60	15.00 ^j	23 ^{bc}	75.00 ^{ab}	32.00 ^{ab}	4.00 ^d	704.2 ^b	62.5 ^b
P ₇₂	17.90 ^f	25.06 ^{cd}	0.75	29.00 ^f	28 ^a	75.10 ^{ab}	15.60 ^d	5.50 ^{cd}	421.6 ^f	68.1 ^b
P ₇₃	17.43 ^f	25.00 ^{cd}	0.70	27.50 ^g	21 ^c	75.00 ^{ab}	16.40 ^d	4.10 ^d	436.7 ^f	57.0 ^c
P ₇₄	16.00 ^g	23.80 ^d	0.80	27.40 ^g	24 ^{bc}	70.60 ^b	25.50 ^{bc}	6.70 ^{ab}	732.6 ^b	56.2 ^c
P ₇₅	15.00 ^h	23.80 ^d	0.65	27.35 ^g	21 ^c	70.65 ^b	21.00 ^{cd}	6.90 ^b	455.1 ^f	36.9 ^d
P ₇₆	14.90 ^h	24.70 ^{cd}	0.85	42.00 ^d	23 ^{bc}	70.50 ^b	21.50 ^{cd}	5.00 ^c	540.6 ^d	38.0 ^d
LSR _(0.05;18)			NS							

Means with different superscripts in the same column are significantly different. P₁ = Ntok mfang, P₂ = Ndana, P₃ = Nte oka, P₄ = Ikpmfang, P₅ = Afia mfri, P₆ = Ofa bake, P₇ = Ngbolodi

Table 3: Mean value for morphological characters of seven parents of *Talinum triangulare* studied in South Eastern Nigeria

Genotypes	Final plant Height (cm)	Plant height at flowering (cm)	Days to 50% flowering	Basal diameter (cm)	Total No. of branches per plant	No. of branches at flowering	Total No. of leaves per plant	No. of leaves at flowering	Leaf area (sq cm)	Fresh shoots yield
P ₁	35.08 ^c	20.87	15 ^b	1.2	16.28 ^b	4.5 ^b	57.4 ^b	34.48 ^c	516.2 ^b	39.7 ^e
P ₂	58.06 ^a	30.15	45 ^a	0.8	3.55 ^c	2.0 ^c	34.90 ^c	31.39 ^c	677.5 ^b	51.7 ^{bc}
P ₃	33.73 ^{cd}	23.73	15 ^b	1.3	29.13 ^a	7.5 ^a	108.65 ^a	65.58 ^a	943.21 ^a	113.2 ^a
P ₄	47.08 ^b	24.80	17 ^b	1.2	18.30 ^b	4.0 ^b	61.96 ^b	43.20 ^b	1089.3 ^a	71.0 ^b
P ₅	27.07 ^{cd}	20.75	18 ^b	0.7	4.1 ^c	1.37 ^c	24.4 ^d	20.5 ^c	372.5 ^{bc}	22.8 ^d
P ₆	26.50 ^{cd}	20.00	20 ^b	0.7	4.9 ^c	1.25 ^c	21.7 ^d	20.0 ^c	397.3 ^{bc}	23.8 ^d
P ₇	25.5 ^d	20.25	21 ^b	0.7	3.6 ^c	1.4 ^c	22.4 ^d	22.3 ^c	304.4 ^c	20.5 ^d
LSR _(0.05;18)		NS		NS						

Means with different superscripts in the same column are significantly different. P₁ = Ntokmfang, P₂ = Ndana, P₃ = Nte oka, P₄ = Ikpo mfang, P₅ = Afia mfri, P₆ = Ofa bake, P₇ = Ngbolodi, NS = Non Significant

role in the expression of these traits. The primary effect here is the modification of the genotypic potentials. If selections is relaxed, the less desirable allelic traits will be maintained in the population at a higher frequency, bearing in mind, the quantitateness of the traits which

are controlled by multiple genes (McClean, 2003). This is true with the findings of Nicholas (1980), who study the effect of environment on the expression of genotype in *Talinum triangulare* and concluded that, any year to year variations in yield for any one genotype is largely an

effect of the environment. Number of leaves at flowering and the total number of leaves per plant had a low heritability estimate of 12% each, indicating strong environmental effects. Variance components of these traits showed that plant height, basal diameter, number of branches at flowering, number of leaves at flowering and number of leaves per plant has a high environmental variance (r^2_e) as against a low genotypic variance (r^2_g). Thus, would be influenced by environmental factors, suggesting the possibility of raising their performance by improving management practices such as soil fertility, irrigation and other agronomic practices (Hamdi *et al.*, 2002). Application of organic manure, green manure, mulch and inorganic fertilizers among other agronomic practices, such as pests and weeds control, erosion control as applicable in tropical environment, enhances soil conditions and fertility, thus boosting productivity. This agreed with the findings of Taisma and Terrara (2003), in which case, water availability (an important environmental parameter in *Talinum triangulare* production) was manipulated under natural condition and seasonal changes. This resulted in a range of leaf characteristics and reproductive output. The marked effect of environment on most metric characters as compare to heredity could also, be clearly seen in biomass allocation, chlorophyll content and leaf water content, as soil water and photoperiodism pronouncedly reduced fecundity in *Talinum triangulare* (Terrara, 1999). This is also in consonant with the findings of Alejandro *et al.* (2003), who reported changes in photochemical activities induced by water deficits in *Talinum triangulare*.

CONCLUSIONS

The accessions differs significantly for all yield related parameters assessed, thereby providing a wide genetic base for *Talinum* breeding programmes. Shoots yield which is the major economic portions of the crop varied among the hybrids. This hold a good phenomenon to the breeders and farmers, as they will have a good number of genetically diverse accessions to work with and vegetables for markets and home consumption respectively. This parameters also implies a better indicator of yielding ability of *Talinum triangulare* and thus can be built into selection indices for rapid improvement of the crop.

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