THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE Morphological Characterization and Hybridization of Talinum Triangulare Land Races for Desirable Metric Characters in South Easte...

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Morphological Characterization and Hybridization of *Talinum Triangulare* Land Races for Desirable Metric Characters in South Eastern Nigeria

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Abstract:
Seven (7) Land races of Talinum triangulare (Jacq.) Willd obtained from different part of major Talinum producing states of Nigeria federation were grown at the Michael Okpara University of Agriculture, Umudike, Nigeria, in 2002 and 2003 cropping seasons for morphological characterization and hybridization for desirable characters. The objectives was to characterise and describe the differences observed in the land races and thus established the potential of local or traditional cultivars as sources of materials for future crop improvement and afford availability of characterized and improved planting materials to farmers. The result of the qualitative characters revealed great variations in growth habit, flower colour, style bearing stigma, inflorescence, leaf shape, stem and pods colours. Plant colours were relevant in term of their carotenoid properties and attractiveness to insect's pollination. The colour varied from white flowers to purple and pink flowers in P_5, P_2 and others (P_1, P_3, p_4, P_6 and P_7) respectively. There were significant variation at ($P<0.01$) probability level in the land races for quantitative characters such as final plant height and at flowering, number of branches per plant and at flowering, number of leaves per plant and at flowering, leaf area and fresh shoots yield. The F_1 hybrids also showed significant differences in these desirable metric characters, thus indicating that the land races of Talinum triangulare are genetically diverse and could be explored in the development of single cross hybrids for high yield. The implication of the results to plant breeding, germplasm collection and conservations as well as quality assurance is discussed.

Keywords: *Talinum triangulare (Jacq.) Willd, Characterization, Hybridization, Land Races, Qualitative and Quantitative characters.*

1. 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), Som-chin (Thai), Kumumanu (Papuan-Australia), Grasse' (French) and Krokot belanda (Indonesia).

Talinum triangulare (Jacq.) Willd is widely grown in the tropical regions as leaf vegetable. It grows to about 30-100cm high, bearing small pink, white or light purple flowers and fleshy leaves with swollen tap-roots. The crop is grown in West Africa (Rabaihayo, 1994 and Okafor et al., 1997), South Asia and South East Asia (ACB, 2004; Siemonsma and Piluek, 1993), warmer part of North and South America (Anderson, 1999; Boose and Holt, 1999). It is one of the most important leaf vegetables in Nigeria, especially 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 (Denton, 1997). It is used in thickening of soup and increased the bulk of stews (Daniel, 2004). Its also has medicinal properties (Siemonsma and Piluek,1993), where the roots is used as tunic for general weakness, possible substitute for ginseng, to treat inflammation and swelling in South East Asia (ACB, 2004).The leaves and the fresh shoots are used in the preparation of laxative and curative portions against measles in children (Akpan, 1982). Department of Biological science, University of Calabar, Nigeria (Unpublished). Its single factor of being high in oxalic acid content (an anti nutritional factor) (Akachukwu and Fawusi, 1995) may limit consumption by those suffering from kidney disorders, gout and rheumatoid arthritis (Wikipedia, 2006).

Nigeria has an abundant *Talinum* germplasm resource. Different species of the genus have been in cultivation for decades especially in South Eastern and Western Nigeria. 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 varietals 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, but there is the tendency for the population to be heterogeneous due to their floral propensity for insect pollinations (Gill, 1988). Most of the cultivars extensively grown in Nigeria are not traits specific in terms of yield, quality and resistance to drought and diseases, probably due to the environmental plasticity on the crop. The seeming similarity existing in the morphology of these land races have been presenting problem of choice to farmers and confines them to indiscriminate use of poor planting materials with attendant hardship.

The rich diversity of the indigenous leaf vegetables of Nigeria has been documented by several researchers including Okigbo (1977), Okafor (1979, 1983) and Adebooye et al. (2003), but there has been little or no work done on *Talinum triangulare* such as in-depth genetic or morphological characterization and controlled hybridization (Opabode and Adebooye, 2005). A major problem with the indigenous leaf vegetables of Nigeria is that they have not been selected for desirable metric characters and no genetic or biotechnological research have been done on them including *Talinum triangulare*. Therefore, knowledge of the morphological or genetic diversity among the available land races is an important prerequisite for preliminary evaluation of this crop. The concept of morphological characterization is very important in plant breeding, especially when it is desired to study and compare the performance of each accession and in hybrid combinations (Epenhuijsen, 1974). In this era of biotechnology, genetic diversity studies involving characterization of crop germplasm featured the use of molecular markers such as Amplified Fragment Length Polymorphisms (AFLP), Random Amplified Polymorphic-DNA (RAPD), Inter Sequence Simple Repeats (ISSR) and DNA based marker system (Balasaravanan et al., 2003 and Devarumath et al., 2002). This is a potential area for further research in *Talinum* species. This present study is aimed at characterizing *Talinum triangulare* land races morphologically and to identifying species that could be use in hybridization work for the development of high yielding hybrids.

2. Materials and Methods

The accessions characterized and evaluated were made up of seven (7) outstanding land races or traditional cultivars collected from different part of *Talinum* producing belt of the country especially Akwa Ibom, Abia, Cross River, Kwara and Ebonyi states. The seven promising land races were grown, evaluated and used for reciprocal diallel crosses to assess their desirable metric characters for possible use in high yield hybrids development programme. The 42 resulting F_1 hybrids were represented by 280 plants and grown in a Randomized Complete Block Design (RCBD) with four (4) replications. Each replicate has seven (7) experimental units. The entries were planted at a spacing of 30 x 30 cm, using one 10 cm cutting per hole^{-1}. Missing stands due to the activities of insect pests were supplied 2 weeks after planting (WAP). Hand weeding, irrigations and other cultural practices were done when necessary.

Observations were made on both qualitative and quantitative characters. 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.

Qualitative data generated were used for preliminary evaluation of the accessions. Characterization was done using International Plant Genetic Research Institutes IPGRI/ FAO multiple-crop passport descriptor, 2001 to compare the morphological similarities of the land races.

Quantitative characters measured were 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 per plant and at flowering, leaf area and fresh shoots yield. The data were subjected to analysis of variance using the procedure for RCBD as outlined by Steele and Torrie (1980). Duncan's Multiple Range Test (DMRT) was used to separate the means where significant differences existed according to Little and Hills (1972). The qualitative characters scored were plant growth habit, primary leaf colour (at emergence), terminal leaf colour (at maturity), leaf shape, leaf tip, leaf arrangement, leaf posture and leaf texture; flower peduncle, pedicel, sepal colour, petal colour, style exsertion and stigma; stem colour at emergence and at maturity, stem shape, pod colour, pod shape and seed colour as shown in Table 5 A, B, C, D and Table 6. All scoring was done in the field between the hours of 10-12.00 am local time. The data matrix of numerical code of the accessions and qualitative traits was standardized (mean = 0, and standard deviation = 1) and used for principal component and cluster analysis (PCA) as outlined by Ofori et al. (2006). The first two components of the PCA were used to derive the principal component plot to determine the relationships among the accessions according to Jibu, et al. (2006). The principal component analysis (PCA) was used to examine the interrelationships among the set of qualitative characters used in morphological characterization of the land races, and also to identify character(s) or traits that contributed significantly to the differences among the accessions. The mean values from the highest and lowest latent vectors were used to determine the threshold for selecting important contributing variables according to Manzano et al. (2001).

3. Results

The result of the qualitative traits of the *Talinum triangulare* land races studied are shown in Table 5 A, B, C, D and Table 6. The primary leaf colours (at emergence) were light-red 40%, cherry-red 20% and light-green 40%. This was later change to different leaf colours at maturity. However, the terminal leaf colours (at maturity) were green 60% and deep-green 40%. There was no pale colour leaves from any of the land races except that at ageing, leaves turn yellowish or variegated and fell off in most of the accessions. The leaf surfaces were smooth and with unserrated margin, terminating at a notched tip recorded for 80%, and pointed tip 20%. Most of the land races had club-shaped leaflets 90% and lanceolated shapes present were 10%. Three distinct stem colours were observed in the field especially at maturity. They were red-stripped stem starting from each node and spreading towards the internodes. This colour constituted of about 30% and pale-green stalks without colour strip were 60% and cherry-red 10%. At the emergence of the crop, during germinations, the stalk colours were cherry-red 20%, red 20% and light green 60%.

In the flowers, the prominent parts scored were the inflorescences, the sepals, the peduncles and the style which sustain the stigma posteriorly. The petal colours were pink 60%, white 20% and light purple 20%. The sepals light green 80% and green 20%. The peduncles were green 80% and cherry-red 20%. The nature of the style position or posture and colour were noted as inserted, exserted and at same level with stamen. Land races with inserted style were 5%, exserted 70% and same level with stamen or moderately exserted 25%. Style colours were pink 80%, and white 20%.

The inflorescences were cymose or multiparous and triangular in shape except in P_2 which was rounded, constituting 80% and 20% respectively. The pods surfaces were smooth in all the land races. They showed two colours at different stages of its development. Light-green 20% and green 80% at immature stage. But at maturity towards dehiscence, they change to light-green 80% and deep-green 20%. The pod shapes were all rounded types, with dark-brown seeds 80% and black seeds 20%. At immature stage seeds from land races were all white. All flowers opened and closed at between 10-11.00 am and 3-4.00 pm respectively, except flowers from P_2 which opened at 3.00 pm and closes at 6.30 pm. The result of the quantitative characters of the parental land races is shown in Table 3. The highest mean plant height at flowering (30.15 cm) was recorded in P_2, followed by P_4 (24.80 cm). At maturity, the final plant height ranged between 33.73 cm (P_3) and 58.08 cm (P_2) among the parental land races. The means of the various quantitative characters of the F_1 hybrids studied are shown in Table 2. There were significant differences at ($P< 0.01$) recorded for such metric characters as height per plant and at flowering, number of branches per plant and at flowering, number of leaves per plant and at flowering, numbers of days to 50% flowering, leaf area and fresh shoots yield. Basal diameter showed no significant difference among the hybrids

The result of the principal component analysis (PCA) is presented in Table 4. The four principal components accounted for 59.20%, 20.30%, 10.40% and 10.10% respectively, of the total variations base on the qualitative traits under evaluation. Primary leaf colour at emergence and terminal leaf colour, leaf shape and tips; and flower colour had high positive loading in the first principal component While stem colour, pod colour and seed colour had low loading component on separation of the land races.

4. Discussions

The magnitude of differences expressed in colours and shapes of leaves, stems, flowers and pods in the land races could be very useful as genetic markers. All the land races except P_2 and P_5, which had light purple and white flowers respectively, possesses pink flower (petals) colour. While very few accessions were lanceolated in their leaf shape, majority were club-shaped. Also except P_2 which showed pointed leaf tip, all other land races had notched leaf tips with majority of them having horizontal leaf posture. Broad leaf status was observed only in P_4, others showed sizes ranging from medium to small. However, in all the cases, textures of the matured leaves were found to be smooth and succulent with entire margin. These attributes enhances the marketable quality of the crop and are highly valued by the consumers. Differences in the floral structure, inflorescence types, peduncle, style inserted or exserted and growth habit could also serve similar purposes in the characterization of germplasm and in the studies of inheritance (Ofori et al., 2006). The main economic portions of the crop reside on the quantitative or metric characters such as final plant height and at flowering, number of leaves per plant and at flowering, number of branches per plant and at flowering and fresh shoots yield. The number of leaves per plant and at flowering, plant height and number of branches were relevant in terms of their contributions to the overall shoots yield (Nya and Eka, 2007).

The morphological characterization of the parental land races indicated that plant stalk colour was cherry-red in P_2, green with red-stripped in P_3 and P_4 and light-green in all others. However, their crosses (F_1) showed no clear distinction in these qualitative characters except crosses involving parent combination of P_2 which showed dark-purple to cherry-red. This was earlier reported by Schippers (2000) to be very much environmentally influenced. The parental land races differed significantly at $P< 0.01$ for all the metric characters studied. This provides a wide genetic base for *Talinum triangulare* breeding programme. Mean shoots yield per plant varied between the ranges of 39.88 g (P_1) to 113.13 g (P_3) in the parental cultivars and between 35.5 g ($P_{1\,4}$) and 86.8 g ($P_{3\,4}$) in the F_1 hybrids. Leaf area per plant followed similar trend. This implies yield advantage of the parental land races planted by stem cuttings (asexually) over the crosses raised by seeds (sexually) as earlier reported by Grubben (1977).

Mean of plant height were 58.08 cm (P_2) for parent and 34.25 cm ($P_{4\,2}$) for crosses as the highest plant height. All the crosses except $P_{4\,2}$ and $P_{1\,2}$ had a mean height shorter than the shortest parent P_3 (33.73 cm). This behaviour in respect of plant height is of particular interest to both plant breeders and the farmers. This indicated the tendency of the F1 hybrids to go dwarfism which is a good phenomenon when dealing with lodging. It follows that medium plant height genotypes can be bred by hybridization between the tall (P_2) and the short stature (P_3) land races, followed by progeny selection for advantage. This is also in line with the finding of Ogunbodede, (1997). Mean number of branches per plant showed crosses having higher number of branches than the parents. This finding indicated that all the F_1 hybrids outdo the least parent in terms of number of branches per plant. Previous findings by Ariyo (1989) had shown that number of branches per plant is important indices for rapid improvement of yield related characters. This is also relevant in terms of their contribution to the total number of leaves per plant and consequently in the overall shoots yield (Nya and Eka, 2007). However, the evaluations of the quantitative characters indicated that these metric traits were very important as good indicators for yielding ability which could be built into selection indices for Talinum triangulare improvement programmes. And in this present study, diversity among the seven (7) land races of *Talinum triangulare* have been unveiled using morphological characterization, thus revealing more genetic reservoir and tools for exploring and identifying superior genotypes that could be use for *Talinum* improvement.

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Annexure

Serial No.	Genotype Name	Local Name	Collection Site/source	Status of Accession	Reference
1.	P_1	Ntok mfang	Arable farms Mbiabong	Land races or Traditional Cultivars	Schippers, 1997
2.	P_2	Ndana	Horticultural Garden, Umuahia	Traditional cultivars	Epenhuijsen 1974
3.	P_3	Nteoka	Fadama farms Umudike	Traditional cultivars	Schippers 2000
4.	P_4	Ikpo mfang	Market garden Calabar	Traditional cultivars	Schippers 2000
5.	P_5	Afia mfri	Fadama project Mbiabong, Ini.	Traditional cultivars	Siemonsma and Pileuk, 1993
6.	P_6	Ofa bake	Ishiagu, Eboyi State	Traditional cultivars	-
7.	P_7	Ngbolodi/Gbure	Ilorin, Kwara state	Local cultivars	-

Table 1: Name and sources of Parental land races of Talinum triangulare used

	Principal components (P C).			
	P C 1	P C 2	P C 3	P C 4
Eigeinvalues variance	2.79	3.04	1.57	1.38
% total contribution	59.20	20.30	10.40	10.10
% accumulated eigenvector	54.40	20.10	15.30	10.20
Primary leaf colour (at emergence)	0.32	0.35	0.16	-0.28
Terminal leaf colour (at maturity)	0.46	0.12	0.56	0.29
Leaf shape	0.47	0.28	0.24	0.29
Leaf tip	0.56	0.27	-0.06	-0.02
Stem colour	0.57	0.22	0.59	0.27
Flower colour	0.51	0.17	0.16	0.15
Pod colour	0.17	-0.15	0.14	-0.05
Seed colour	0.21	-0.18	0.33	-0.01

Table 2: Matrix of eigeinvalues and vectors of Principal components for qualitative traits

Genotype	Primary Leaf Colour	Terminal Leaf Colour	Leaf Shape	Leaf Tip	Leaf Posture/ Arrangement	Leaf Texture
P_1	red	green	club-shape	notched	alternate semi-erect.	smooth
P_2	cherry-red	deep green	obtuse/ Lanceolated	pointed	horizontal	smooth
P_3	light red	green	club-shape	notched	alternate	smooth
P_4	light red	green	club-shape	notched	alternate	smooth
P_5	light green	deep green	club-shape	notched	horizontal	smooth
P_6	light green	deep green	club-shape	notched	alternate	smooth
P_7	light green	green	club-shape	notched	Alternate crowding at nodes	smooth/ succulent

Table 3: Morphological Variation in Qualitative Characters of the Parental land races

Genotype	Growth	Stem Colour Habit	Stem Colour at Emergence	Stem Shape at Maturity	Stem Texture
P_1	erect with	light green	pale few branches	terete	glabrous
P_2	erect	cherry-red	deep red	terete	glabrous
P_3	dwarf/ semi Prostrates	light green	red-stripped	angular at apex	glabrous
P_4	semi-erect	red	red-stripped	angular	glabrous
P_5	semi-erect	light green	pale green	terete	glabrous
P_6	semi-erect	light green	pale green	terete	glabrous
P_7	semi-erect	light green	pale green	terete	glabrous

Table 4: Morphological variation in qualitative character of the parental land races

Genotype	Inflorescence Type	Peduncle Colour	Sepal Colour	Petal Colour	Style Position	Opening Time	Closing Time
P_1	Cymose/ multiparous	green	light-green	pink	same level with stamen	10 am	3pm
P_2	multiparous	cherry red	green	light purple	exserted	3pm	6pm
P_3	multiparous	green	light green	pink	exserted	10am	3pm
P_4	multiparous	green	light green	pink	exserted	11am	4pm
P_5	multiparous	green	light green	pink	slightly exserted	11am	4pm
P_6	multiparous	green	light green	pink	exserted	10am	3pm
P_7	multiparous	green	light green	pink	exserted	10am	3pm

Table 5: Morphological Variation in the qualitative characters (floral) of the parental land race

Genotype	Fruit/Pod	Immature Type	Mature Pod Colour	Pod Shape Pod Colour	Seed Colour
P_1	dehiscent	green	light green	rounded	dark-brown
P_2	dehiscent	light green	deep green	rounded	black
P_3	dehiscent	green	light green	rounded	dark-brown
P_4	dehiscent	green	light green	rounded	dark-brown
P_5	dehiscent	green	light green	rounded	dark-brown
P_6	dehiscent	green	light green	rounded	dark-brown
P_7	dehiscent	green	light green	rounded	dark-brown

Table 6: Morphological variation in the qualitative characters of the parental land races

Descriptors and Class	Frequency of Class (%)					
	0	1	2	3	4	5
Primary leaf Colour 1= green, 2= cherry red, 3= light green, 4= purple	-	40	20	40	-	-
Terminal leaf shape. 1= oval, 2= Club-shape, 3= lanceolated, 4= elliptic	-	-	90	10	-	-
Terminal leaf colour. 1= deep green, 2= green, 3= variegated, 4= pale	-	40	60	-	-	-
Leaf tip. 1= notched, 2= pointed, 3= round.	-	80	20	-	-	-
Stem colour at maturity. 1= pale green, 2= cherry red, 3= red-stripped, 4= brown.	-	60	10	30	-	-
Stem colour at emergence. 1= light green, 2= cherry red, 3= red.	-	60	20	20	-	-
Sepal colour. 1= light green, 2= green, 3= red.	-	80	20	-	-	-
Petal colour. 1= pink, 2= White, 3= purple.	-	60	20	20	-	-
Peduncle colour. 1= green, 2= cherry red, 3= brown,	-	80	20	-	-	-
Style position. 1= inserted, 2= exserted, 3= slightly exserted, 4= same level with stamen	-	5	70	5	20	-
Inflorescence stalk. 1= triangular, 2= rounded, 3= flat.	-	80	20	-	-	-
Immature pod colour. 1= green, 2= dark green, 3= deep green, 4= light green.	-	80	-	-	20	-
Mature pod colour. 1= green, 2= deep green, 3= light green	-	-	20	80	-	-
Pod shape. 1= round, 2= flat, 3= heart-shaped.	-	100	-	-	-	-
Immature seed colour. 1= white, 2= red, 3= black, 4= dark brown.	-	100	-	-	-	-
Mature seed colour. 1= white, 2= red, 3= dark brown, 4= brown.	-	-	100	-	-	-

Table 7: Frequency distribution of qualitative traits descriptors for parental land races