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Short communication

THE DIVERSITY AND ASSOCIATED YIELD COMPONENTS OF ENSET (*ENSETE VENTRICOSUM*) BASED ON ITS AGRO-MORPHOLOGICAL TRAITS FROM SOUTHERN ETHIOPIA

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ABSTRACT: There are many enset clones in different agro-ecologies. Farmers classify their landraces and give them different names based on several attributes. In order to illustrate the existing diversity within and between enset cultivars, 122 named enset accessions from five different geographical zones of Southern Ethiopia namely, Sidama, Gamogofa, Dauro, Gurage and Wolita, were considered in this study. These landraces were maintained at Areka Agricultural Research Centre. Each landrace had four individual plants. Data were recorded based on eight quantitative agro-morphological traits. These traits were plant height, pseudostem height, leaf numbers, pseudostem circumference, granted corm, maturity period (years from planting till flowering), *bulla* and fibre yield. Based on the relative magnitude of Manhattan similarity matrix and dendrogram on hierarchal complete linkage cluster analysis, all 122 enset accessions were grouped into 11 clusters. The highest genetic diversity was revealed from enset accessions of Gamogofa and Gurage zones. Principal Component Analysis showed that the first three principal components accounted for 77% of the total variation. Weight of corm granted, fibre yield, pseudo stem circumference, maturity period, leaf numbers and *bulla* yield were among the most important morphological descriptors which accounted for more than 50% of the variation expressed in this germplasm collection. The significant and positive correlation among yield component characters of enset was revealed but maturity period showed negative and highly significant correlation to enset yield at P>0.001.

Key words/phrases: Cluster analysis, diversity, *Enset ventricosum*, eigen values, principal component analysis

INTRODUCTION

Enset (*Ensete ventricosum (*Welw.) Cheesman) belongs to the order *sctaminae*, the family *musaceae.* The *Musaceae* family is subdivided into the genera *Musa* and *Ensete* (Simmonds, 1966). Enset system of cultivation is considered to be one of the last remaining sustainable, indigenous agricultural systems found in Africa (Terrence, 1996). Enset occurs in wild forms in East, Central and South Africa. Even though the banana fruit is known worldwide enset (*Ensete ventricosum*) is only cultivated as a crop in Ethiopia (Taye Bezuneh *et al.*, 1967*)*. Outside Ethiopia, the use of enset is reported from Vietnam, where it provided an emergency food during the Second World War. In parts of north and central Vietnam, the growing point was used as a vegetable (Admasu Tsegaye and Westphal, 2002). Enset grows at a wide range of altitudes however it grows luxuriously at elevation between 2000 and 2750 masl under rain fed conditions (Taye Bezuneh *et al.,* 1967). The crop is grown in many regions but the dwellers of the central and southwestern parts of Ethiopia are the only people who use enset as a staple and co-staple crop (Stanley, 1966). These regions are among the most densely populated in the whole of Ethiopia and are inhabited by more than 11 ethnic groups, which show great variation in culture and agricultural practices (Admasu Tsegaye and Westphal, 2002). The Ethiopian Central Statistical Agency (2011) indicates that 3,020.143 km^2 of land is covered by enset crop and about 6.9 million quintals of enset yields were produced in 2010/11 production season.

There are many enset clones in different agro ecologies. Farmers classify their landraces and give them different names based on several attributes that distinguish the landraces from one another. The names given by farmers to the different enset clones separate the landraces linguistically, phenotypically and in terms of their utilization value (Admasu Tsgaye, 2002). This paper presents the results of investigation on the diversity among different one hundred twenty two named enset (*Ensete ventricosum*) landraces with their agro-morphological traits.

MATERIALS AND METHODS

In order to illustrate the existing diversity within and between enset varieties, 122 named enset landraces, collected from six geographical zones of southern Ethiopia namely, Sidama, Gamogofa, Dauro, Gurage and Wolita, were considered. These landraces were maintained at Areka Agricultural Research Centre since 1994. Each landrace had four individual plants. Data were recorded based on eight quantitative agromorphological traits. Plant height, pseudo stem height, leaf numbers and pseudo stem circumference were recorded each year starting from transplanting to harvesting of the plant. The other four quantitative traits, namely, average weight of granted corm, maturity period (years from planting until flowering), *bulla* and fibre yield were collected during harvest. The average consecutive year's standardized raw data were considered for statistical analysis. Statistical analysis was computed using the computer program Gen Stat discovery, edition 3 and NTSYpc, version 2 (Rohlf, 1998).

RESULTS AND DISCUSSION

Enset agro-morphological diversity determined by cluster analysis

The cluster study, based on eight agro-morphological characters resulted eleven cluster groups. The dendrogram of 122 enset accessions evaluated based on Manhattan similarity matrix, is shown in Figure 1. Enset landraces from Gamogofa zone were grouped in cluster eight. Cluster six is composed of five accessions only from Dauro zone. This group was characterized by highest *bulla* yield. Clusters one, three and eleven (nine) consisted of one accession each from Wolita, Gamogofa, and Gurage, respectively. Cluster one was characterized by enset landraces with taller plant height and higher fibre yield. The accession included in cluster eleven was characterized by smaller plant height, pseudo stem height, and weight of corm granted, *bulla* yield and fibre yield. On the other hand, cluster three was characterized by highest value of pseudo stem circumference, pseudo stem height and weight of corm granted.

The genotypes from the same origin fell in different groups and those from different origin were group under the same cluster. Similar results reporting the absence of relationship between genetic diversity and geographical origins were by Prasad and Sing (1990) in maize, and by Gemechu Keneie *et al.* (2005) in Faba bean. Rezai and Frey (1990) reported similarly, that genetic diversity was not apparently related to geographic diversity in some crops. Clusters seven, four and ten consisted of maximum number of enset accessions which were 39, 24 and 22, respectively. The above clusters included enset landraces from Gurage, Dauro, Sidama, Gamogofa and Wolita. The genotypes included in cluster ten were characterized by smaller pseudo stem circumference. Collections from Gamogofa zone were distributed over seven different clusters, and enset landraces from Gurage zone were grouped into six different clusters. This indicates the presence of more genetic diversity in landraces of these regions as compared to the others. The presence of a significant variation among enset germplasms due to yield and yield component characters was also reported from evaluation studies conducted on different enset landraces at Areka Agricultural Research Centre (Table 1).

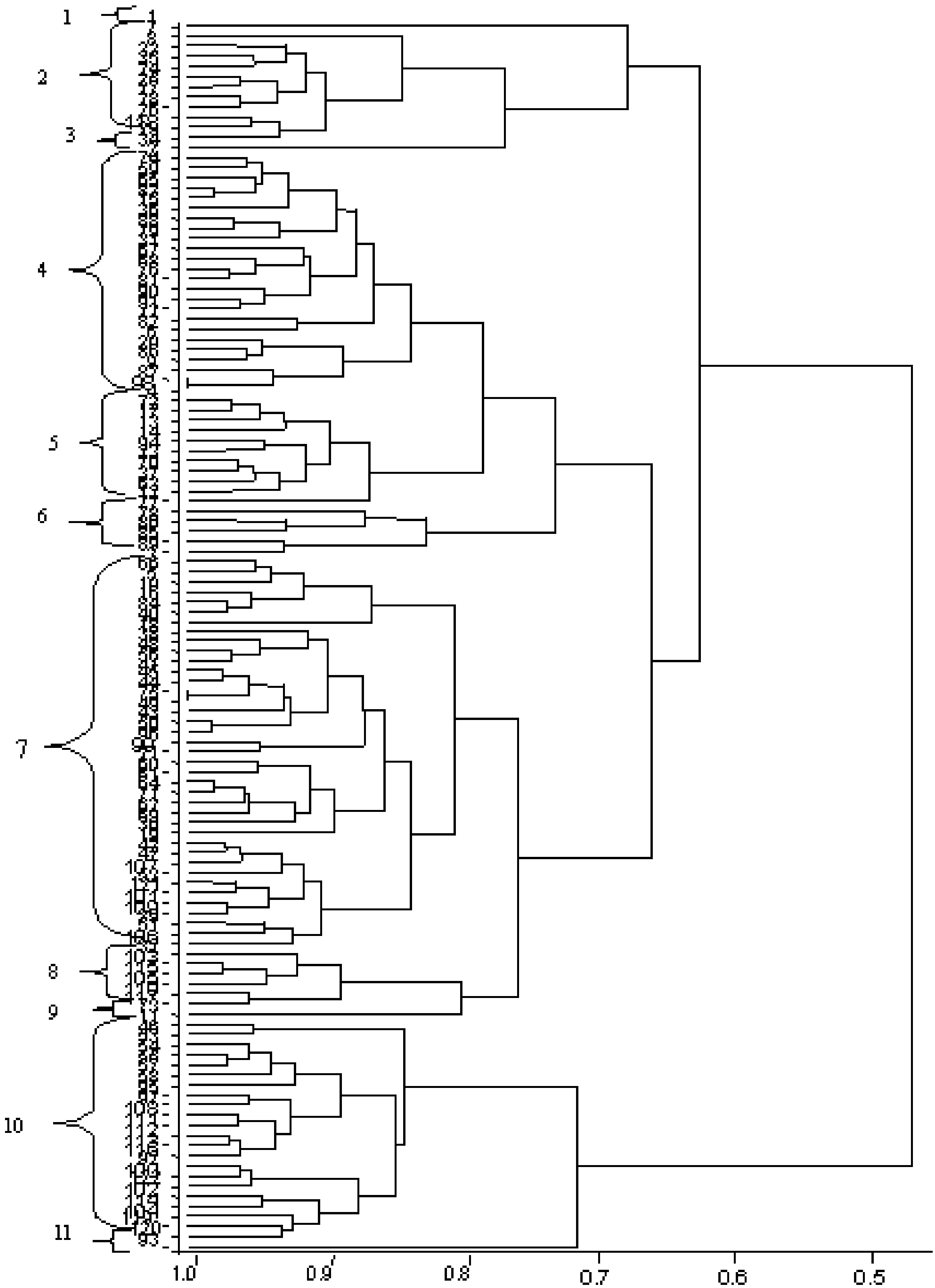

Figure 1. Relationship between 122 enset (*Ensete ventricosum*) accessions collected from Southern Ethiopia based on complete linkage hierarchical cluster analysis.

Table 1. Mean performance of enset clones collected from Southern Ethiopia to yield and yield component characters evaluated under Areka Agricultural Research Centre field conditions.

Characters (unit of measurements)	Number of clones evaluated	Range	Maximum value (clone name/locality)	Minimum value (clone name/locality)
Plant height (metre)	255	4.9	7.4 (Bumbe/Kembata)	2.5(Gufeniye/Gurage)
Pseudo stem height (metre)	256	2.2	3.3 (Bosena/Waka)	5.5 (Ketsie/Chencha)
Pseudo stem circumference (metre)	257	2.2	2.7 (Midasho/Sidama)	0.5 (Busuriya/Waka)
Number of leaves (count)	257	20.7	27 (Weret/Guragie)	6.3 (Tasurga/Waka)
Year of flowering (years)	270	6.2	7.4 (Korttie/Kembata)	1.2 (Shedodiniya/Waka)
Kocho yield (ton/hectare/year)	144	53.84	54.9 (Digomerza/Kembata)	1.06 (Demorjate/Gurage)
Bulla Yield (ton/hectare/year)	268	56.39	56.9 (Digomerza/Kemabata)	0.591 (Zinkie/Chencha)
Fibre Yield (ton/hectare/year)	245	528.65	557.42 (Heckacha/Sidama)	28.77 (Chochi/Chencha)

Source: Atnaf Bekele *et al.* (2008).

The level of inter-clusters similarity between clusters 1 and 11 (47%), 6 and 11 (53.1%), 3 and 11 (53.1%), 1 and 10 (60%), 9 and 11 (64.5%), 1 and 9 (64.6%), 4 and 11 (64.6%), 2 and 11 (65.6%), 3 and 10 (66%), 3 and 9 (66%), 1 and 8 (67.5%), 1 and 3 (67.9%) and 1 and 5 (68.2%) was minimum. The maximum inter-cluster similarity was found between clusters 5 and 8 (89.9%), 4 and 5 (88.6%), 5 and 10 (87.9%), 7 and 8 (87.5%), 8 and 10 (87.5%), 4 and 7 (87.1%), 2 and 4 (86.8%), 4 and 8 (86.3%), 2 and 7 (86.1%), 2 and 8 (85.9%), 5 and 7 (85.8%), 7 and 10 (83.4%), 4 and 10 (82%), 2 and 9 (80.6%) and 4 and 9 (80.0%). Maximum level of intra-cluster similarity was recorded within clusters. This indicates the presence of less genetic diversity within each clustering group.

Enset agro-morphological diversity determined by principal component analysis

The relationship among 122 enset accessions studied was further examined by results of principal component analysis (PCA). This analysis reduces the eight variables into three principal components with eigen values greater than one. PCA showed that the first three principal components accounted for 77% of the total variation. The highest proportion of the total variability was obtained by the first component (34%). This was contributed by pseudo stem circumference, weight of corm granted and fibre yield characteristics. In PC2 the traits which contributed better than others to the total variability were maturity period, number of leaves and *bulla* yield. Plotting of the first and second coordinates exhibited highly consistent results with that of cluster analysis.

Association of enset yield with its yield component characters

Correlations were computed for yield and yield component characters in enset. The character association of plant height observed positive and highly significant correlation to pseudo stem circumference, number of leaves, weight of corm granted and *bulla* yield at $p>0.001$. Similarly, pseudo stem circumference exhibited positive and highly significant association to weight of corm granted and *bulla* yield resulted in positive and highly significant correlation with fibre yield. This association of traits among yield component characters is in good agreement with the works of Endale Tabogie *et al.* (1994), who reported positive correlation among vegetative measurements of enset, and Teketel Mekiso (1976) who indicated that plant height and pseudo stem circumference had positive correlation.

However, in this study a highly significant and negative correlation was obtained between maturity period and plant height, *bulla* and fibre yield. The study also revealed significant and negative correlation of maturity period with pseudo stem circumference. This negative association of maturity period to enset yields may be due to perennial nature of enset plant. Furthermore, enset yield is expressed in ton/hectare/year unit as described by Shank and Ertiro Chernet (1996). This result is in line with Atnafua Bekele *et al.* (2008) who reported that highest enset yields (*kocho*, *bulla* and fibre) were obtained from early maturing enset plants rather than the late maturing types.

CONCLUSION AND RECOMMENDATION

Cluster analysis revealed that enset landraces from Gamogofa and Gurage zones had more genetic diversity compared to other locations in southern Ethiopia. Hence, more emphasis should be given to these regions during enset improvement activities. Enset farmers have their own way of sustainable traditional conservation system but this system needs more support to overcome loss of the important germplasms.

According to principal component analysis results, morphological traits that best discriminate between the accessions were weight of corm granted, fibre yield, pseudostem circumfrance, maturity period, leaf numbers and *bulla* yield which accounted for more than 50% of the variations expressed in this germplasm collection. Hence, these agro-morphological characters can be considered as important markers during enset morphological characterization in field condition.

From this study it is observed that positive and highly significant correlation is present between plant height and *bulla* yield. This enables to pre estimate better yielding enset varieties based on their yield components. However, in this study highly significant and negative correlation was also obtained between maturity period and plant height, *bulla* and fibre yield. It also revealed significant and negative correlation with pseudo stem circumference. Previous research results also indicated that highest enset yield was obtained from early maturing enset plants rather than the late maturing types. Thus, unless there is any social value and quality difference between enset yield of these two maturity groups, it is better to use early maturing types of enset plants to get more yield.

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