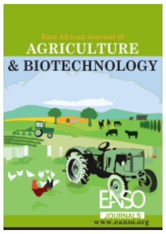

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Original Article

Effect of Spider Plant Accessions on Phenotypic Traits: Implications for Breeders and Farmers in Kenya

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ABSTRACT

Spider plant (*Cleome gynandra L.*) is an important African leafy vegetable (ALV) that has been used by local African communities as a source of nutrition in their diets for many years. The plant has recently attracted an increasing demand for its highly nutritive and health-promoting bioactive compounds important in combating malnutrition and reducing human degenerative diseases. Despite the great value of the spider plant, its supply and cultivation remain low, a factor attributed to unavailability of superior genotypes. This study carried out at Ruiru Sub-county, Kiambu County in Kenya sought to establish the influence of genotypic variation on spider plant phenotypic diversity for future breeding and conservations. Experimental plots were set up in the field in Ruiru using split-plot design with three replications. Analysis of variance (ANOVA) was used to assess the significance of variables. Results indicated that genotypes MLSF3, UGSF36, UGSF14, and MLSF17 produced the highest number of flowers, large petioles, big stem sizes and large leaf area respectively. In conclusion, the study recommends the adoption of genotypes MLSF17, UGSF14, UGSF36 and MLSF3 by farmers considering their outstanding positive effect on phenotypic traits.

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INTRODUCTION

Knowledge on phenotypic diversity of the existing spider plant accessions is a milestone in the improvement of spider plant supply and cultivation. The spider plant is a highly nutritious indigenous vegetable in Kenya. Agriculture is the mainstay of Kenya's economy providing the basis of development for other sectors of the economy. The Agricultural sector contributes about 30% of the gross domestic product and accounts for over 75% of the total labour force (MoA, 2017). It is envisaged that the sector will continue to play a leading role in stimulating and supporting the country's economic growth mainly through the vibrant horticulture industry (HCDA, 2014). According to the Horticultural Crops Development Authority of Kenya (HCDA, 2014), vegetables contributed over 40% of the total value of horticultural production between 2011 and 2013. Thirty percent (30%) of the vegetables valued at USD 247 million were exported mainly to the European Union (HCDA, 2014).

In recent times, African leafy vegetable (ALVs) are increasingly playing a central role in the horticulture sector. The percentage contribution of ALV such as cowpeas, African nightshades, vegetable amaranths, jute mallow and spider plant has been remarkably rising; their value in the domestic market in Kenya rose from 4.3% in 2011 to 5% in 2013 (HCDA, 2014). The area under these vegetables has also increased over the years from 31,864 ha in 2011 to over 40,000 ha in 2013 leading to a production increase from 31,868 MT in 2011 to 178,268 MT in 2013 (HCDA, 2014). The ALVs has several advantages over other exotic vegetables. They have high nutritive value (Chweya & Mnzava, 1997), medicinal value and health benefits (Kokwaro, 2009; Olembo *et al.*, 1995; and De Albuquerque et al., 2007). These ALVs are also important in conserving a rich diversity of genotypes of importance for future generations and breeding (Chadha, 2003).

Cleome gynandra (L.) is among the most important traditional leafy vegetables widely used in Africa (Schippers, 2000). In English, *Cleome gynandra* is commonly known as spider flower or plant, cats' whiskers, spider wisp, and African cabbage. This tropical plant has different names among the African dialects. Among the different *Cleome* species, *Cleome gynandra* is the most widely used as a leafy vegetable but *Cleome monophylla* and *Cleome hirta*, which are close relatives, are also used occasionally (Vorster *et al.*, 2005). The spider plant is used as both food and medicine. Van Rensburg et al. (2004) also noted that ALVs are rich in micronutrients and vitamins hence could play an important role in alleviating hunger and malnutrition. The plant has been evaluated for nutrient content and showed to have high values especially for calcium, magnesium, iron, zinc, vitamin A, C and E (Chweya & Mnzava, 1997), making it suitable for combating malnutrition and lifestyle diseases especially in Sub-Saharan Africa (Van Jaarsveld et al., 2014; Van Rensburg et al., 2004). There are a number of genetically diverse populations among spider plant accessions, but it is not clear to what extent they are genetically different (K'Opondo, Muasya & Kiplagat, 2005; Maundu *et al*., 1999; Wasonga, 2014).

MATERIALS AND METHODS

Field trials were carried out in order to evaluate, select and document spider plant varieties, which included P6, MLSF17, MLSF3, UGSF9, UGSF12, UGSF14, UGSF25, UGSF36, and IP3. Field experiments were conducted in Ruiru District situated in Central Province, Kenya, between March - June 2011 and April - July 2012. The geographical coordinates of the study site are latitude 1° 9' 0'' S, and longitude 36° 58' 0'' E. The area is classified under sub-tropical highland climate, by Köppen climate classification system and receives an average annual rainfall of 1,025 mm. Temperature range is 10 – 26 °C with an altitude of 1,795 m above sea level. The soils are typically red on undulating topography. Main human activities include coffee farming, dairy, and horticulture (MoA, 2017). The experimental factors tested consisted of both qualitative and quantitative traits. The traits included the number of flowers, size of petioles, stem size and leaf area. The experiment was laid out as a split-plot design with three replications. Analyses of variance (ANOVA) were done using SAS (SAS 9.1.3) for dry weight, leaf area, height and number of leaves. The level of significance was at $p<5\%$ and mean separation was done using LSD.

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RESULTS

Influence of Spider Plant Genotype on the Number of Flowers

There was a significant difference among genotypes in Ruiru trials. Genotypes significantly influenced (P≤ 0.05) the number of flowers across different harvesting periods during the long rainy season (*Table 1*). In the first harvesting period (seven weeks after crop establishment), there was no significant difference in the number of flowers among the various genotypes (P≤ 0.05). The probable attribution to this insignificance could be because the plant at seven weeks has not attained its full growth potential to express all genotypic traits inherent within MLSF3 and UGSF36 significantly produced the highest number of flowers compared to all other genotypes in the tenth week of harvesting period (P≤ 0.05). Similarly, UGSF9, UGSF25 and UGSF14 significantly produced more flowers than IP3, P6 (control) and MLSF17 in the tenth. There was no significant difference between the number of flowers produced in the second season at the seventh and tenth week of harvesting (*Table 1*). The depletion of micronutrients in the soil by the first crop necessary for inducing flower formation by spider plant could be the probable cause for few flowers in the second season establishment. The high number of flowers produced by MLSF3 and UGSF36 implies that the genomes are best suited for use as a source of seed for multiplication purposes. Furthermore, it attracts flower-visiting insects that are pivotal to both natural and agricultural ecosystems (Kevan, 1990). Furthermore, a good variety for further value addition on spider plant seeds by farmers for agribusiness.

Table 1: Effect of spider plant genotype on the number of flowers of spider plant across different harvesting periods in Ruiru season one and two

Genotype	**Harvesting period in weeks**			
	Season One		**Season Two**	
	7	**10**	**7**	**10**
P6	0.1133a	2.24bc	0.0611a	2.524a
MLSF17	0.2122a	1.441c	0.0511a	1.603a
MLSF3	0.2033a	4.693a	0.1011a	2.339a
UGSF9	0.1144a	3.638ab	0.0644a	2.522a
UGSF12	0.1944a	1.064a	0.0633a	1.807a
UGSF25	0.17a	3.74ab	1.0022a	1.928a
UGSF36	0.1056a	4.969a	0.0267a	1.576a
IP3	0.2233a	2.611bc	0.0178a	2.433a
UGSF14	0.0911a	3.994ab	0.01a	1.897a
LSD	**0.1423**	**1.12**	**0.951**	**0.8449**
CV%	**34.9**	**2.7**	**119.2**	**32.1**

Means in the same column followed by different letter (s) are significantly different at P<0.005

Effect of Spider Plant Genotype on the Size of Petioles of Spider

There was a significant difference among genotypes on the size of petioles in Ruiru during season one. Genotypes significantly influenced (P≤ 0.05) the size of petioles across different harvesting periods in the long rain season (*Table 2*). In the seventh week, the sizes of petioles were not significantly different between various genomes. However, in the tenth week, there was significant difference in the size of petioles among different spider plant accessions. UGSF14 and UGSF36 produced significantly bigger petioles compared to all other accessions. The size of petioles has an influence on the size of leaves and hence the ultimate yields of the plant. In the second season, there was no significant difference in the size of petioles of spider plant both across and within harvesting periods.

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Table 2: Effect of spider plant genotype on the size of petioles of spider plant across different harvesting periods in Ruiru season one and two

Genotype	Harvesting period in weeks			
	Season One		**Season Two**	
	7	**10**	**7**	**10**
P6	0.2778a	0.7911ab	0.2711a	1.217a
MLSF17	0.2644a	0.7356ab	0.2467a	1.059a
MLSF3	0.37a	0.6289ab	0.3711a	1.227a
UGSF9	0.2067a	0.9189ab	0.1711a	1.118a
UGSF12	0.2178a	0.9ab	0.22a	1.157a
UGSF25	0.2367a	0.8556ab	0.2433a	1.163a
UGSF36	0.3022a	1.0411a	0.3278a	1.153a
IP3	0.2556a	0.4322b	0.1922a	1.053a
UGSF14	0.2333a	1.0278a	0.1944a	0.936a
LSD	**0.1565**	**0.308**	**0.1578**	**0.3765**
CV%	**10.5**	**19.6**	**44.8**	**23**

Means in a same column followed by different letter (s) are significantly different at P<0.005

Effect of Spider Plant Genotype on the Size of Stem

Genotypic variation in spider plants significantly influenced ($P \leq 0.05$) the size of stems across different harvesting periods in Ruiru (*Table 3*). Results indicated that UGSF14 produced bigger stems per plant than all other genotypes in the tenth week of harvesting (see *Table 3*). IP3 produced the least stem size of all the genotypes tested (*Table 3*). There were no significant differences in the size of stem per plant as a result of genotypic variation in the seventh week of harvesting. Similarly, for the greenhouse, the aboveground diurnal temperature ranged from 15-37ºC for the first season and 11-31ºC for the second season. The greenhouse plants began to flower five weeks after planting compared to outdoor that started flowering later in week six. Similar observations were made in the second season where there was no significant differences in stem size in the seventh week of harvesting among genotypes. Nevertheless, MLSF17 produced the biggest stem size compared to all other genotypes in the tenth week of harvesting (Table 3.3). However, the difference between UGSF14 and MLSF17 was not significantly different in the second season.

Table 3: Effect of genotype on the size of the stem of spider plant across different harvesting periods in Ruiru season one and two

Genotype	Harvesting period in weeks			
	Season One		**Season two**	
	7	**10**	**7**	**10**
P6	1.018a	4.36cd	0.8022a	1.799ab
MLSF17	1.187a	4.669bc	1.0889a	2.682a
MLSF3	1.046a	5.792abc	0.8211a	2.203ab
UGSF9	1.001a	4.294cd	0.77a	2.226ab
UGSF12	1.131a	4.449cd	0.9322a	2.181ab
UGSF25	1.066a	4.618bcd	0.7933a	2.544ab
UGSF36	1.279a	6.166ab	0.7278a	2.221ab
IP3	0.977a	3.029d	0.5989a	1.627b
UGSF14	1.174a	6.887a	0.5889a	2.202ab
LSD	**0.5114**	**1.012**	**0.403**	**0.6544**
CV%	**6**	**11.5**	**18.3**	**16.1**

Means in a same column followed by different letter (s) are significantly different at P<0.005

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Effect of Genotype on the Leaf Area of Spider Plant

Genotypic variation significantly (P<0.005) affects leaf area of spider plant across different harvesting periods (Table 3.4). In the seventh week of harvesting, P6 and MLSF17 produced the largest leaf area than all other genotypes whereas, in the ninth and tenth week of harvesting, IP3 and MLSF17 had the biggest leaf area respectively compared to all other genotypes. Genotypes UGSF12 and UGSF25 had the least leaf area among all genotypes.

Table 4: Effect of genotype on the leaf area of spider plant across different harvesting periods in Ruiru

Genotype	**Harvesting period in weeks**		
	7	**9**	**10**
P6	251.5a	923ab	1167ab
MLSF17	217.3a	1033.4ab	1281a
MLSF3	183b	1012.3ab	1153ab
UGSF9	223.4ab	924.7ab	1059ab
UGSF12	174.8b	961.7ab	1138ab
UGSF25	202.1ab	798.6b	971b
UGSF36	218.6ab	899.6ab	1148ab
IP3	192.3ab	1085.1a	1205ab
UGSF14	237ab	892.3ab	1222ab
LSD	**40.7**	**168.8**	**17.5**
CV%	**2.3**	**14.2**	**8.5**

Means in a same column followed by different letter (s) are significantly different at P<0.005

CONCLUSION AND RECOMMENDATIONS

Spider plant accessions significantly influence both qualitative and quantitative traits of the crop. MLSF3 and UGSF36 produced more flowers than all other genotypes. Phenotypically, the size of petioles depended much on the type of genotype used. Large petiole sizes were produced by UGSF14 and UGSF36, while all other genotypes evaluated produced smaller petiole sizes in both seasons. Similarly, stem sizes depended on the genotype used and UGSF14 produced big stem plants compared to all other genotypes. The findings corroborate the study by Lemaire *et al.* (1992), that there is a positive quantitative correlation of dry matter partitioning among stems and leaf size on Lucerne *(Medicago sativa)*. Similarly, for short-season crops such as spider plant, planting heavier seed-genotypes is advantageous since they establish faster (Houssard and Escarré, 1991). IP3 and MLSF17 produced big leaf area compared to all other genotypes evaluated. Young stems, petioles and flowers are edible and contribute significantly to the overall yield of spider plant. In conclusion, the study recommends adoption of genotypes MLSF17, UGSF14, UGSF36 and MLSF3 by farmers considering their outstanding positive effect on phenotypic traits of leaf area, number of flowers, size of petioles and stem size. Furthermore, the same genotypes should be considered for future selection and improvement by both farmers and breeders.

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