Journal of Biology, Agriculture and Healthcare www.iiste.org
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online) DOI: 10.7176/JBAH
Vol.9, No.10, 2019

Assessment of Relationships Between Genotypic Variation and Growth and Yield of Spider Plant 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 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 of Kenya sought to establish the influence of genotypic variation on growth and yield of spider plant. Experimental plots were set up in the field in Ruiru and greenhouse in Juja. Analysis of variance (ANOVA) was used to assess the significance of variables. Results indicated that genotypes MLSF17, UGSF14, P6, UGSF9 and UGSF36 yielded outstanding agronomic performance. However, there was no significant difference among growth parameters of genotypes in greenhouse compared to the field experiments.
Keywords: African leafy vegetable, Cleome gynandra, genotypes
DOI: 10.7176/JBAH/9-10-10
Publication date:May 31st 2019

1.0 INTRODUCTION

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, 2008). 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.

In recent times, ALVs are increasingly playing a central role in horticulture. The percentage contribution of ALV such as cowpeas, African nightshades, vegetable amaranths, jute mallow and spider plant 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 have several advantages over other exotic vegetables. They have high nutritive value (Chweya and Mnzava, 1997), medicinal value and health benefits (Kokwaro, 1993; Olembo *et al.,* 1995; and De 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 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.,* 2002). Spider plant is used as both food and medicine. It was noted by Jansen van Rensburg *et al.,* (2004) that ALVs, which are rich in micronutrients and vitamins, 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 (Mnzava 1997), making it suitable for combating malnutrition and life style diseases especially in Sub-Saharan Africa (WHO, 2005; FAO, 1993). 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), 2011; Maundu *et al*., 1999).

2.0 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; IP3. , agronomic performance. 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 latitude1° 9' 0" S, and longitude 36° 58' 0" E. The area is classified under sub-tropical highland climate, by Köppen climate classification system,

ISSN 2224-3208 (Paper) ISSN 2225-093X (Online) DOI: 10.7176/JBAH
Vol.9, No.10, 2019

receives average annual rainfall of 1,025 mm. Temperature range is 10-26°C with 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, 2008). The experimental factors tested consisted of three nitrogen levels. The nitrogen levels were manure, 2.6 g N/plant and 5.2 g N/plant. 1 bucket, each weighing 10kg of fine and well decomposed cattle manure were put in each sub-plot measuring 1.2 m by 3 m. The experiment was laid out as a complete randomized design (CRD) 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.

3.0 RESULTS

3.1 Influence of spider plant genotype on the number of leaves across different harvesting periods in Ruiru season one

There was no significant difference among genotypes in Ruiru trials. Genotypes significantly influenced (P≤ 0.05) the number of leaves across different harvesting period's long rain season (table 3.10). The control variety (P6) resulted into more leaves per plant when compared with UGSF9 and UGSF25 in the first harvesting period. In the seventh week of harvesting, MLSF17 significantly produced more leaves when compared to P6 (P≤ 0.05). UGSF14 significantly produced more leaves than IP3, UGSF25, UGSF12, MLSF3 and MLSF17 in the eighth week of harvesting. There was a significant difference in the number of leaves produced between the various genotypes in the ninth week of harvesting. UGSF35 produced more leaves than IP3 and UGSF9 at significant level of r (P≤ 0.05). Similarly, the amount of leaves produced by UGSF14 was significantly higher than that of UGSF9 in the long rains (Table 3.10).

Table 3.10: Effect of spider plant genotype on the number of leaves of spider plant across different harvesting periods in Ruiru season one

	Harvesting period in weeks				
Genotype	**5**	**6**	**7**	**8**	**9**
P6	0.5656a	0.8289a	1.612b	3.064b	3.171bcd
MLSF17	0.3544ab	1.0367a	3.2a	3.024b	3.649abc
MLSF3	0.4511ab	0.9422a	2.173ab	2.61b	3.887abc
UGSF9	0.28b	0.7256a	1.866ab	3.384ab	2.454cd
UGSF12	0.3744ab	1.0111a	2.481ab	2.979b	3.499abcd
UGSF25	0.2844b	0.9411a	2.322ab	2.479b	3.569abc
UGSF36	0.3578ab	1.1078a	2.64ab	3.379ab	4.89a
IP3	0.3589ab	0.7189a	2.636ab	3.292b	1.928d
UGSF14	0.3756ab	0.8978a	2.406ab	4.96a	4.376ab
LSD	**0.159**	**0.4107**	**0.96**	**1.025**	**0.981**
CV%	**1.4**	**7.2**	**9.1**	**0.7**	**13.1**
p-value	**0.028**	**0.553**	**0.084**	**0.001**	**0.001**

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

In the second season, results indicated that genotype significantly influenced (P≤ 0.05) the number of leaves produced (table 3.11). MLSF3 produced significantly more leaves in the second season than IP3 at the sixth week of harvesting (table 3.11). There were no significant differences in the number of leaves produced by various genotypes in the fifth, seventh, eighth and ninth weeks of harvesting in the second season.

Table 3.11: Effect of spider plant genotype on the number of leaves of spider plant across different harvesting periods in Ruiru season two

	Harvesting period in weeks				
Genotype	**5**	**6**	**7**	**8**	**9**
P6	0.3478a	0.7789ab	1.828a	3.104a	4.434a
MLSF17	0.3022a	1.9722a	2.018a	3.512a	4.18a
MLSF3	0.2922a	0.5667ab	1.962a	3.23a	4.097a
UGSF9	0.1933a	0.5833ab	2.017a	3.612a	4.081a
UGSF12	0.3567a	0.7022ab	1.906a	3.331a	3.864a
UGSF25	0.2178a	0.7333ab	2.144a	2.929a	3.857a
UGSF36	0.2156a	0.7544ab	2.164a	3.002a	4.501a
IP3	0.1933a	0.4289b	1.744a	2.876a	4.091a
UGSF14	0.2944a	0.6811ab	2.119a	3.329a	3.996a
LSD	**0.1202**	**0.3288**	**0.7028**	**0.99**	**1.099**
CV%	**47.1**	**20.9**	**22.4**	**25.1**	**19.6**
p-value	**0.034**	**0.108**	**0.946**	**0.82**	**0.949**

Means in a same column followed by different letter (s) are significantly different at P<0.05

3.2 Influence of genotype on the number of leaves across different harvesting periods in Greenhouse season one

Genotypic variation in spider plants significantly influenced ($P \leq 0.05$) the number of leaves across different harvesting periods in the greenhouse (Table 3.12). Results indicated that UGSF9 produced more leaves per plant than UGSF36 and MLSF17 in the fifth week of harvesting (table 3.12). There were no significant differences in the number of leaves produced per plant as a result of genotypic variation beyond five weeks. For greenhouse, above-ground diurnal temperature ranged from 15-37^{o}C for the first season and 11-31^{o}C 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 Ruiru first season, indicating a positive correlation between temperature and the time to flowering

Table 3.12: Effect of spider plant genotype on the number of leaves of spider plant across different harvesting periods in Ruiru season two

	Harvesting period in weeks				
Genotype	**5**	**6**	**7**	**8**	**9**
MLSF17	15.22b	27.56a	31a	41.89a	19.51a
P6	15.56ab	26.56a	34.22a	45.11a	19.8a
UGSF14	15.89ab	26.56a	38.67a	51.22a	19.42a
UGSF36	15.33b	27.78a	37.67a	47.22a	19.82a
UGSF9	17a	27.44a	37.44a	47.56a	19.88a
LSD	**1.143**	**8.26**	**8.74**	**11.45**	**2.678**
CV%	**47.1**	**20.9**	**22.4**	**25.1**	**19.6**
p-value	**0.024**	**0.997**	**0.378**	**0.564**	**0.995**

Means in a same column followed by different letter (s) are significantly different at P<0.05

3.3 Effect of genotypic variation of spider plant on yields across different harvesting periods in Ruiru season two

Genotypes of spider plant significantly influenced ($P \leq 0.05$) yields across different harvesting periods in Ruiru season two (Table 3.13). MLSF3 resulted in significantly higher yields than IP3 in the seventh and eighth week of harvesting. However, in the ninth week, there was no significant different in yields between MLSF3 and IP3 but MLSF3 significantly exceeded yields of UGSF36 (Table 3.13).

ISSN 2224-3208 (Paper) ISSN 2225-093X (Online) DOI: 10.7176/JBAH
Vol.9, No.10, 2019

Table 3.13: Effect of genotypic variation on the yields of spider plant across different harvesting periods in Ruiru season two

	Harvesting period in weeks				
Genotype	**5**	**6**	**7**	**8**	**9**
P6	1551a	1055.6a	1783ab	1770ab	1701ab
MLSF17	1749a	1496.7a	1973ab	1828ab	1822ab
MLSF3	1179a	845.6a	1983a	1954a	1862a
UGSF9	1147a	811.1a	1968ab	1664ab	1760ab
UGSF12	1357a	1077.8a	1687ab	1339bc	1479ab
UGSF25	956a	806.7a	1873ab	1416b	1446ab
UGSF36	1247a	973.3a	1586ab	1459b	1258b
IP3	742a	625.6a	1449b	1308b	1422ab
UGSF14	1047a	706.7a	1656ab	1612ab	1502ab
LSD	**662.1**	**575**	**324.7**	**439.8**	**360.5**
CV %	**41.8**	**37.8**	**12.8**	**15.2**	**10**
p-value	**0.118**	**0.88**	**0.013**	**0.045**	**0.015**

Means in a same column followed by different letter (s) are significantly different at $P<0.05$

4.0 DISCUSSION

Plant selection for superior traits is an old practice among most researchers either through breeding or phenotypic observation. Desirable characteristics such as biomass, yield, resistance to pests and diseases are considered. The level of management is critical factor influencing spider plant fresh leaf yields. Besides the genetic influence, growing conditions and management practices undertaken during growth have important bearing on crop nutritional status (Hutchinson *et al.*, 2006). Application of manure and/or fertilizer and the stage of maturity of spider plant are critical in determining the phytochemical, nutritional and sensory characteristics of the vegetable (Kebwaro, 2013). The improvement in yields for the second season in the field was also attributed to better management coupled with lessons learnt from the previous season. The trial was set under similar conditions to minimize the effect of environmental variations such as storms and pests. Greenhouse above-ground diurnal temperature ranged from 15-37 ºC for the first season and 11-31 ºC for the second season. The plants in greenhouse began to flower five weeks after planting compared to outdoor that started flowering later in week six. Similar observations were made in Ruiru season I. This may be attributed to high temperature stress that induce early flowering. Yields are also being improved through selection of genotypes of spider plant, which has intensified in the recent past (Onim and Mwaniki, 2008; Masinde, 2011), since commercial varieties have shortfalls such as yield, nutrient, and geographical diversity. Limited access to quality seed and shortage of suitable cultivars has been key cause of low spider plant productivity (Abukutsa-Onyango, 2010b)

In terms of seed weight, heavier *Rumex acetosella* seeds have higher relative growth rate (RGR) in the first 7 weeks after germination in the field experiment than greenhouse. Thereafter, lighter seeds had twice RGR greater than those from heavier seeds. Nonetheless, after 10 weeks, there was no significant difference in RGR. This suggests that a trade-off between allocation to sexual and vegetative reproduction occurs over successional time (Houssard and Escarré, 1991). Studies have shown that seed weight factor has greatest importance during the early stages of plant growth. According to Ocxcmann (1942), tomatoes, cucumbers and soybean plants grown from lighter seeds had slower initial growth rate, which persisted until the end of the sixth week. Therefore, there is a positive correlation for this period of growth. Since spider plant takes relatively short growth period of about twelve weeks, the light seeded genotypes are less likely to catch pace with the heavier seeded accessions after the period. This is consistent with the findings of this study where lighter seeded genotypes such as IP3 and MLSF3 that generally had poor agronomic performance and vice versa. The study also documented higher mortality rate among seedlings grown from seedlings of lighter weight than among seedlings grown from heavier seeds. This difference in mortality rate is probably due to differences in plant vigour.

5.0 CONCLUSION AND RECOMMENDATIONS

Appearance, colour, aroma and/or taste and medicinal properties influence acceptability of vegetable lines. Two methods were used to measure consumer choices: the vegetables were cooked and a panel invited to taste and fill in questionnaire; and market survey was done to determine purchase preference. Food colour is an indicator of available phytochemicals present e.g. carotenoid, lycopene and anthocyanin. The main challenge with this study was its wide scope. For instance, the highest yielding genotypes were not necessarily the ones most preferred by neither the growers nor the consumers, nor will it be nutritionally endowed variety. Consequently, informed compromise must therefore be reached in order to make invaluable and sound recommendations. The wider crop

ISSN 2224-3208 (Paper) ISSN 2225-093X (Online) DOI: 10.7176/JBAH
Vol.9, No.10, 2019

and human factors should be considered.

In conclusion, the study recommends adoption of genotypes MLSF17, UGSF14, P6, UGSF9 and UGSF36 for adoption by farmers considering their outstanding agronomic performance. However, it is recommended to undertake phytochemical analysis for each genotype and effect of high nitrogen stress on plant toxin accumulation. Also, trained panellists should be involved in the sensory test to verify whether there could significance difference among consumers.

REFERENCES

Abukutsa-Onyango, M. (2007). The diversity of cultivated African leafy vegetables in three communities in western Kenya. *Afr J of Food Agri, Nutr and Development,* **7** 3

Alva, A. K., Paramasivam, S., Fares, A., Delgado, J. A., Mattos, D. Jr and Sajwan, K. (2008). Nitrogen and Irrigation Management Practices to Improve Nitrogen Uptake Efficiency and Minimize Leaching Losses. Journal of Crop Improvement. Vol. 15 issue 2. Pages 369-420

Blom-Zandstra, M. (2008). Nitrate accumulation in vegetables and its relationship to quality. Annals of Applied Biology. ***115*** *3*

Chandel, B. S., Pandey. S. and Kumar, A. (1987). Insecticidal evaluation of some plant extracts against *Epilachna vigintioctopuctata.* Fabr. *Coleoptera coccinellidae*. Indian J. Entomol. **49**: 294-296.

Chweya JA, Mnzava NA (1997). Cat's whiskers: Cleome gynandra L. Promoting the conservation and use of underutilized and neglected crops, 11. Rome: IPGRI.De 2007

HCDA. (2014). Horticulture Data 2012-2013 Validation Report. Nairobi, Kenya.

Herman, M. (2011). Inorganic fertilizer vs. cattle manure as nitrogen sources for maize *(Zea mays L.)* in Kakamega, Kenya. JUROS vol 2 (22)

Janzen DH. Interactions of seeds and their insect predators/parasitoids in a tropical deciduousforest. In: P.W. Price (ed.). Evolutionary strategies of parasitic insects and mites. P

Kebwaro, D.O., Onyango, C.A., Sila, D.N., Masinde, P.W., Nyaberi, M. N. and Mutoro, K.W. (2013). Influence of nitrogen application on total phenolics and flavonoids during growth of five selected accessions of spider plant (*Cleome gynandra* L)

K'opondo FBO, Muasya RM, Kiplagat OK. A review on the seed production and handling of indigenous vegetables (spiderplant, jute mallow and African nightshade complex) In: MO Abukutsa- Onyango AN Muriithi VE Anjichi K Ngamau SG Agong A Fricke B Hau, H Stutzel (Eds). Proceedings of the third horticulture workshop on sustainable horticultural. Jansen van Rensburg *et al.,* (2004)

Macer, D. (1973). Strawberry growing complete. Pg. 82-86 164 WJ Holman Ltd, Dawlish. UK

Masinde, W. P. and Agong, G. S. (2011). Plant growth and leaf N of spiderplant under varying nitrogen supply Afr. J. Hort. Sci. (December 2011) 5:36-49.

Maundu PM, Njiro EN, Chweya JA, Imungi JK, Seme EN (1999a). Kenya. In: The biodiversity of traditional leafy vegetables (Chweya JA and Eyzaguirre PB Eds.). International Plant Genetic Resources Institute, Rome, Italy, pp. 51-84

Mauyo, L. W., Anjichi, V. E., Wambugu, G. W. and Omunyini, M. E. (2008). Effect of nitrogen fertilizer levels on fresh leaf yield of spider plant (*Gynandropsis gynandra*) in Western Kenya. Scientific Research and Essay 3 (6) 240-244.

Mnzava NA, Schippers RR (2004). Brassica carinata A. Braun. In: Plant Resources of Tropical Africa 2. Vegetables (Grubben GJH and Denton OA Eds.). PROTA Foundation, Wageningen, Netherlands/Backhuys Publishers, Leiden, Netherlands/CTA, Wageningen, Netherlands, pp. 119-123.

Ministry of Agriculture (MoA) Annual report, 2017. www.kilimo.go.ke.

Ocxcmann (1942

Ojiewo, C., Tenkouano, A., Oluoch, M. and Yang, R. (2010). The role of AVRDC (The World Vegetable Centre) in vegetable value chains. Afr, J. Hort. Sci. **3**: pp 1-23

Olembo, N. K., Fedha, S.S. and Ngaira, E.S. (1995). Medicinal and Agricultural Plants of Ikolomani, Kakamega District, Kenya.

Onim, M. and Mwaniki, P. (2008). Cataloguing and evaluation of available community/farmers-based seed enterprises on African Indigenous Vegetables (AIVs) in four ECA countries. Lagrotech consultants. Kisumu.

Schippers RR (2000). African indigenous vegetables: an overview of the cultivated species. Chatham, UK: Natural Resources Institute/ACP-EU Technical Centre for Agricultural Rural Cooperation, pp. 25-31.

Vorster HJ, Jansen Van Rensburg WS (2005).. Traditional vegetables as a source of food in South Africa: Some experiences. African Crop Science Conference Proceedings. 2005;7:669-671.8. Masinde WP, Ag

Wambani, H., Nyambati, E. M. and Kamidi, M. (2008). Evaluation of legumes as components of integrated soil nutrient management for kale production. Afr. J. Hort. Sci. **1** (2008) pp 91-9.