Journal of AgriSearch 1(4): 201-205
Peer Reviewed Quarterly
ISSN : 2348-8808 (Print), 2348-8867 (Online)

Multivariate Analysis of some Sesame (*Sesamum indicum* L.) Accessions based on Quantitative Characteristics

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ARTICLE INFO

Received on	: 30.09.2014
Revised received on	: 18.10.2014
Accepted on	: 05.11.2014
Published online	: 05.12.2014

ABSTRACT

To estimate phenotypic variation among 43 sesame accessions the present experiment was laid out in a randomized complete block design with three replicates and morphological data on days to flower initiation, days to 50% flowering, petiole length, number of nodes to first flower, plant height at flowering, plant height at maturity, number of days to maturity, length of capsule, seed weight of capsule,1000 seed weight and seed yield per plant were measured. Positive correlation was observed for number of nodes to first flower, plant height at flowering, plant height at maturity, seed weight per capsule and 1000-seed weight with seed yield per plant. Four principal components were identified which accounted for 80.92% of the total variation. All the accessions grouped into five clusters while accessions included in cluster 3 mainly comprised with early flowering, shorter petiole, early maturing and higher seed yield per plant. The results have an important suggestion for morphological categorization and enhancement of sesame breeding program.

Keywords: Cluster analysis, Principal components, Sesame, Variation

INTRODUCTION

Sesame (*Sesamum indicum* L.) is an important oilseed crop of tropical and sub-tropical regions (Singh *et al.*, 2013). It is considered to be the oldest of the oilseed plants and has been under cultivation in Asia for over 5,000 years (Bisht *et al.*, 1998). Sesame is an annual plant that belongs to the family Pedaliaceae. It is called as the "Queen of oil seeds" due to its excellent qualities of the seedoil and meal. It is an important source of edible oil and is widely used in food products especially in bakery foods and animal feed. Sesame oil has medicinal and pharmaceutical value and is being used in many health care products.

Sesame was traditionally grown as a rainfed crop in the dry and intermediate zones of Sri Lanka. At present, it has become an economically important oil seed crop due to the higher domestic and export demand and it is mainly used for snacks and confectionary industry in the country. It is cultivated in about 15,000 ha of which 12,000 ha is cultivated in *Yala* season whilst the balance is cultivated during *Maha* season. Annual sesame production is around 12,000 MT while the productivity is 800 kg/ha (Agstat, 2013).The crop is widely grown in Anuradapura, Moneragala, Jaffna, Mulathivu, Kurunagala and Hambantota districts. Sesame is the only oilseed crop export from Sri Lanka and the annual export volume in year 2012 was 2,025 MT (Agstat, 2013).Although Department of Agriculture, Sri Lanka has released Uma and Malee varieties with high yield potential, many farmers continue to grow local sesame populations with low yields. Genetic diversity of crops plays an important role in sustainable development and food security (Esquinas-Alcazar, 2005), as it allows cultivation of crops in the presence of various biotic and abiotic stresses. The knowledge of nature and magnitude of genetic variability is of immense value for planning efficient breeding programme to improve the yield potential of the genotypes. Multivariate analysis based on morphological characters provides genetic information that will allow the breeder to improve populations by selecting from specific geographic regions (Souza and Sorrels, 1991).The present study was carried out to ascertain the nature and magnitude of genetic divergence among sesame genotypes and to select better accessions for sesame improvement programme.

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MATERIALS AND METHODS

Plant Materials and Experimental Design

The material for the study comprised 43 genotypes of sesame received from Plant Genetic Resources Centre, Gannoruwa and some farmer field collections. The experiment was conducted at the research field of Grain Legumes and Oil Crops Research and Development Centre, Angunakolapelessa, during March to June, 2013 in a randomized complete block design with three replications. Each genotype was sown with the spacing of 30 cm between the rows and 15 cm between the plants within the rows. Recommended agronomic practices advocated by the Department of Agriculture for sesame crop were followed to raise a healthy crop. To know about extent and pattern of agro-morphological diversity observations were recorded on each entry on five randomly selected plants (Singh *et al.*, 2010a). Observations were recorded for yield and yield contributing characters *viz*., days to flower initiation, days to 50% flowering, petiole length, number of nodes to first flower, plant height at flowering, plant height at maturity, number of days to maturity, length of capsule, seed weight per capsule, 1000 seed weight and seed yield per plant. In addition, growth habit (determinate/ indeterminate) and the flower color also recorded

Statistical Analysis

Multivariate analysis including principal component analysis and cluster analysis was done using SPSS software version 16.The correlation coefficients were calculated by using the formulae suggested by Kwon and Torrie (1964). Principal component analysis (PCA) was also carried out with Eigen values > 1.0 were chosen, as proposed by Jeffers (1967). Cluster analysis was carried out to evaluate the level of dissimilarity among the sesame germ plasm. A dendogram was constructed with Euclidian distance.

RESULTS AND DISCUSSION

The range of variation observed among the accessions for all the quantitative characteristics are presented in table 1. A considerable level of variation was observed among the forty three sesame accessions for most of the quantitative traits measured (Table 1). The largest variation was observed for seed yield per plant followed by plant height at flowering, seed weight per capsule and petiole length. The mean seed yield per plant was observed as 55.7 g with a range of 10.4 g and 122.7 g. Relatively, a low level of variability was detected in length of capsule, days to maturity and 1000 seed weight recording coefficient of variation 10.47%, 13.16% and 16.56% respectively. 1000 seed weight ranged from 1.9 g to 3.8 g which shows that accessions are available for higher seed weight. Both earliness and late in maturity are important for plant breeding programs trying for adaptation of sesame germplasms to various ecological regions as well as for researches on photoperiod and thermo-sensitivity (Ashri, 1994; Rehman *et al.*, 2009). Days to maturity of the observed accessions ranged from 82 to 135 days showing a variation that could match with breeding objectives for different environments. However, no variation was observed for flower color among the accessions and almost all the accessions were indeterminate type. Similar results were also recorded by Singh *et al.*, 2010 while working on saffron at Kashmir, India.

Table 1: Variation in quantitative traits of forty three sesame accessions

Characteristic	Mean	Standard Error	CV (%)
Days to flower initiation	42	1.85	22.75
Days to 50% flowering	46.9	1.71	25.65
Petiole length (cm)	44.3	2.11	32.1
No. of nodes to 1st flower	5.9	0.25	28.44
Plant height at flowering (cm)	46.6	3.18	48.83
Plant height at maturity (cm)	83.6	2.77	24.2
Days to maturity	94.6	1.73	13.16
Length of capsule (cm)	24.9	0.38	10.47
Seed weight/Capsule (g)	0.2	0.18	36.86
Seed weight (g)	2.7	0.06	16.56
Seed yield per plant (g)	55.7	4.09	54.29

Correlation coefficients of the eleven quantitative characteristics are given in table 2. Data revealed that number of nodes to first flower, plant height at flowering, plant height at maturity, seed weight per capsule and 1000-seed weight had the positive correlation with seed yield per plant although not significant. The results agreed with similar positive correlation observed by Uzun and Cagirgan (2001) and Sumathi *et al.*, (2007) for plant height and 1000 seed weight with seed yield per plant. Days to flower initiation and days to 50%flowering had significant positive correlation with plant height at flowering, plant height at maturity and days to maturity, in addition they showed negative correlation with seed yield per plant. Gnanasekaran *et al*, (2008) and Yol *et al.*, (2010)had examined negative effect of days to flower initiation and days to 50% flowering on seed yield per plant which comparable with the findings of this research.

Table 2: Correlation coefficients among 11 quantitative traits in sesame germplasm.

Trait **	DFI	50%DF	PL	NFF	PHF	PHM	DM	CL	SW/C	1000SW	SYP
DFI	1	0.991*	-0.04	0.455	0.885*	0.649*	0.961*	0.498	0.016	-0.263	-0.15
50%DF		1	-0.07	0.472	0.913*	0.663*	0.97*	0.503*	0.023	-0.24	-0.131
PL			1	0.293	-0.138	-0.027	0.004	0.252	-0.276	-0.087	-0.216
NFF				1	0.481	0.354	0.521*	0.232	-0.052	-0.12	0.033
PHF					1	0.863*	0.901*	0.579*	0.091	-0.265	0.059
PHM						1	0.675*	0.574*	0.04	-0.276	0.297
DM							1	0.51*	-0.023	-0.197	-0.13
CL								1	0.139	-0.21	-0.013
SW/C									1	0.243	0.136
1000 SW										1	0.159
SYP											1

* Significant at 0.05% level
**DFI -Days to flower initiation, 50%DF - Days to 50% flowering, PL- Petiole length, NFF -Number of nodes to first flower, PHF-Plant height at flowering, PHM- Plant height at maturity, DM -days to maturity, CL -Capsule length, SW/C- Seed weight per capsule,1000 SW-1000- Seed=weight, SYP-Seed yield per plant.

Principal Component Analysis

Multivariate analysis of the accessions showed that the first four Principal Components (PC1 to PC4) having Eigen values > 1.0 and cumulatively accounted for 80.92% of the total variation (Table 3). The first PC accounted for 46.73 % of the total variation, while the PC2, PC3 and PC4 explained 14.81%, 10.13% and 9.25% respectively. The variation in PC1 was largely correlated with days to flower initiation, days to 50% flowering, plant height at flowering, plant height at maturity, days to maturity and length of capsule. PC2 was mainly associated with petiole length and number of nodes to first flower. PC3 and PC4 were mainly associated with yield characteristics.

Table 3: Percentage and cumulative variances and Eigen-vectors on the first four principal components for the characters

Trait	*PC1*	*PC2*	*PC3*	*PC4*
Eigen value	5.14	1.63	1.14	1.02
% of variance	46.73	14.81	10.13	9.25
Cumulative %	46.73	61.54	71.67	80.92
DFI	0.959	0.004	-0.07	-0.145
50%DF	0.972	-0.007	-0.05	-0.123
PL	-0.105	0.917	-0.165	-0.143
NFF	0.495	0.545	0.005	0.068
PHF	0.968	-0.022	-0.05	0.157
PHM	0.776	0.066	-0.141	0.479
DM	0.958	0.082	-0.046	-0.114
CL	0.601	0.38	0.044	0.158
SW/C	0.127	-0.198	0.778	0.109
1000 SW	-0.256	0.049	0.777	-0.002
SYP	-0.063	-0.08	0.12	0.941

DFI -Days to flower initiation, 50%DF - Days to 50% flowering, PL- Petiole length, NFF -Number of nodes to first flower, PHF-Plant height at flowering, PHM- Plant height at maturity, DM -days to maturity, CL -Capsule length, SW/C- Seed weight per capsule,1000 SW-1000- Seed weight, SYP -Seed yield per plant.

Cluster Analysis

Hierarchical cluster analysis based on agro-morphological traits grouped the 43 sesame accessions into five clusters at the rescaled distance of 10 (Fig. 1). There was a wide range of variation in the cluster mean values for most of the characters under study (Table 4).Third cluster contained maximum number of accessions (18) followed by cluster 4 (13), cluster 5 (5), cluster 1(4) and cluster 2 (3). Cluster means for different quantitative characters stated for each cluster are presented in Table 5. Cluster 1 was mainly characterized by short stature, shorter culm length, higher seed weight per capsule and higher 1000 seed weight. Accessions in cluster 2 comprised with late flowering, tall stature, late maturity, longer culm length and lower 1000 seed weight. Cluster 3 was primarily characterized by early flowering, shorter petiole, early maturing and higher seed yield per plant while accessions in cluster 4 were characterized by low seed weight per capsule and cluster 5 consisted with longer petiole.

Table 4: Means of different quantitative traits for different clusters of 43 sesame accessions

Cluster	*DFI*	*50%DF*	*PL*	*NFF*	*PHF*	*PHM*	*DM*	*CL*	*SW/C*	*1000 SW*	*SYP*
1	40.25	44.75	39.80	5.00	29.50	51.65	92.00	22.80	0.24	3.30	20.49
2	72.00	86.00	36.60	9.00	118.67	129.67	133.67	29.33	0.23	2.43	46.49
3	38.44	42.67	33.43	5.33	44.08	85.92	90.06	24.20	0.22	2.76	74.61
4	41.69	45.62	55.38	5.85	40.75	79.24	93.54	25.06	0.15	2.51	35.54
5	39.00	43.60	62.60	7.20	41.30	84.92	92.60	25.94	0.22	3.10	61.33

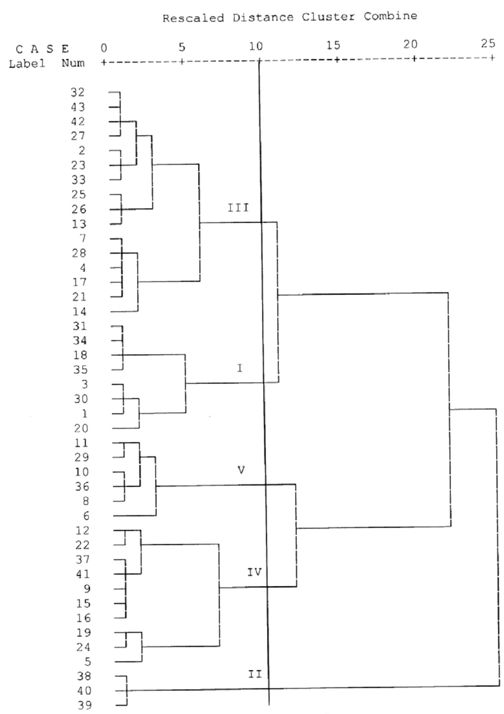

Fig.1. Dendogram using ward's method's for 43 sesame accessions

Hybridization between genetically diverse genotypes in sesame to generate promising breeding material has been suggested by Alarmelu and Ramanathan (1998). The hybridization between the genotypes in the most distant clusters should result in to maximum hybrid vigour and eventually may give rise desirable recombinants. Parents combining high yield potential with wide genetic diversity are likely to yield superior segregants with in short period.

CONCLUSION

A high level of genetic diversity based on morphological traits was observed in the study. The results indicated that the sesame accessions studied had a considerable level of variability that could be exploited and elite sesame germplasmcould be chosen on the basis of important agro-morphological traits for future utilization in breeding programs.

ACKNOWLEDGEMENT

Authors wish to acknowledge Additional Director, and the staff of the Grain Legumes and Oil Crops Research and Development Centre, Anunakolapelessa for their encouragement and support given to conduct the study.

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Correct Citation:

Perera UIP and Pushpakumara RW. 2014. Multivariate Analysis of some Sesame (*Sesamumindicum* L.) accessions based on quantitative characteristics. *Journal of AgriSearch* **1**(4):201-205.