Vegetable Science (2018) 45 (1) : 61-67

Correlation and diversity analysis for economic traits in spine gourd (*Momordica dioica* Roxb.)

Sanjay Bhagat*, SK Sinha and JK Tiwari

Received: November 2017 / Accepted: April 2018

Abstract

The present investigation was conducted with 33 genotypes of spine gourd for estimation of genetic parameters, correlation, principal component analysis and cluster analysis. Fruit yield per plant was observed to be positively associated with 43 significant positive correlations between yield and number of first flowering node, ovary length, single fruit weight and number of fruit per plant. Genetic diversity among spine gourd genotypes was executed through principal component analysis first seven principal component axes accounted for 76.4% variation towards the divergence. Among four clusters cluster III had highest number of genotypes (12) on the other hand cluster I (11) genotypes cluster II (8) and cluster IV contain only two genotypes In PCA and cluster analysis the genotypes grouped into four different clusters based on principal component scores. At present no concrete research work has been done in spine gourd with special emphasis on multivariate analysis through better performing genotypes so as to included in further breeding program. Spine gourd being highly cross pollinated crop, macro propagation through cuttings or micro propagation is found to be beneficial for the commercial exploitation of the horticultural superior genotypes.

Key words: Correlation analysis, principal component analysis, cluster analysis, spine gourd.

Introduction

Spine gourd (*Momordica dioica* Roxb., 2n=2x=28) belongs to the cucurbitaceae family, native of Indo-Malayan region (Rashid 1976), and distributed in India, Bangladesh, China, Malaysia, Nepal, Myanmar, Pakistan, and Sri Lanka. It is widely distributed in tropical and sub-tropical parts of India and adapted to different soil and climatic conditions (Basumatary et al. 2014). Spine gourd is economically important vegetable crop with high food and medicinal value, cultivated for its fruits which is used as vegetable and is known by various names such as Kakrol, Kartoli, and Kankad, Teasel gourd or Bhat Kerala. This popular vegetable has high demand in market because of good nutritional, medicinal value, high keeping quality, ability to withstand long distance transportation, high market price and good export potential. Correlation analysis is a biometrical technique to find out the nature and degree of associations among various traits. Therefore, information on variability of plant characters and association among yield and quality characters are of vital importance in plant breeding programme. The multivariate analysis, and in particular, the principal component and cluster analyses have been utilized for the evaluation of germplasm when studying various traits (Mardia et al., 1979). Evaluation of germplasm is useful not only in selection of core collection but also its utilization in breeding programmes. Various numerical taxonomic techniques have been successfully used to classify and measure the pattern of genetic diversity in germplasm. In order to develop high yielding cultivars resistant to various stresses, exploitation of the gene pool is of paramount importance. A large number of variables are often measured by plant breeders, some of this may not be sufficient discriminatory power of germplasm evaluation, characterization, and management. In such case, principal component analysis (PCA) may be used to reveal patterns and eliminate redundancy in data sets (Adams 1995). There is need to improve its yield potential and make its more acceptable among the indigenous populace. An assessment has been made to identify the differences among the genotypes and major variable which leads to the identification of possible groups and relationships among genotypes.

Department of Genetics and Plant Breeding, RMD College of Agriculture and Research Station, IGKV, Ambikapur-497001, Chhattisgarh
*Corresponding author, Email: bhagatjt1011@gmail.com

Materials and Methods

Thirty three genotypes including check varieties Indira Kankoda-1, PK -5, PK -9, PK -26, PK-34, PK-35, PK-46, KRISHNAPUR, PK-49, RMF-1, RMF-17, RMF-27, RMF-P-4, RMF-7-P-1, PHULLE MD-5-1, PHULLE MD-5-2, NDM-1, NDM-5, RMDSG-1, PK -33, AMBIKA-K-12-1, AMBIKA 13-5, AMBIKA 13-6, RAIGARH, NDM-2, NDM-3, NDM-4, DHARMJAYGARH, RMF-G-39, RMF-G-49, AJSG-3, AJSG-4, AJSG-5 of *Momordica dioica* were collected from different agro-ecological regions of Chhattisgarh. They were maintained at the experimental farm of Rajmohini Devi College of Agriculture and Research Station Ambikapur, Chhattisgarh. The experimental field is located at 20^0 8' N, longitude of 83^0 15' E and altitude of 613.07 m MSL (Mean Sea Level). The place of investigation is a sub-humid region. It receives 1130 to 1250 mm rainfall annually; out of which above 88% is receive during rainy season (June to September).The experiment was conducted consequently for two year during 2015 and 2016 under All India Coordinated Research Network Project on Potential crops at the research and instructional farm of Rajmohini Devi College of Agriculture and Research Station, Ambikapur. Experiment was conducted in Augmented Block design with four blocks; pits of 30 X 30 X 30 cm^3 were prepared in each plot with a spacing of 2m X 2m. The tubers root was planted in earthen pots containing a 2:1:1 mixture of soil, sand and decomposed cow dung on May 2015 and watered. They began to sprouted 20-25 days after potting. The male plants were planted in the field at 8:1 ratio (female: male). The plants were supported by bamboo sticks. When the plants were about 2.5 m. high, they were allowed to climb on rope net hanged vertically up to 2.5m from the soil surface. The data analysis was worked out as per procedure of Singh and Chaudhary (1985). All the quantitative traits were analyzed by numerical taxonomic techniques using the procedures cluster and principal component analysis (Sneath and Sokal 1973) with the help of computer software STAR 2.0.1 for windows. Cluster analysis was conducted on the basis of average distance k-means and genotypes in each cluster were then analyzed for basic statistics.

Results and Discussion

Correlation result presented in table 1 revealed that days to first flowering had significant positive association with pistil length and fruit length. Number of first flowering node expressed significant positive correlation with plant height, ovary diameter, single fruit weight, number of fruit plant^{-1}, fruit yield kg plant^{-1}, number of seed fruit^{-1}, and yield kg ha^{-1}. Number of stem plant^{-1} had significant positive association with leaf length, leaf width, fruit length, fruit diameter, number of seed per fruit and 100 seed weight. Plant height had significant association with ovary length, style length, but showed significant negative correlation towards number of seed fruit^{-1}. Number of ridge on stem expressed significant positive correlation with style length, pistil length, but they showed significant negative correlation towards fruit length, number of fruit plant^{-1}, fruit yield kg plant^{-1} and yield kg ha^{-1}. Leaf length had significant correlation with leaf width, fruit length, fruit diameter, number of

Table 1: Correlation coefficient of twenty (20) quantitative traits evaluated in spine gourd germplasm

CHARACTER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Days to 1st.flowering	1.00	-0.08	-0.20	0.19	0.03	0.03	0.14	0.14	0.03	0.03	0.03	0.30*	0.36*	0.08	-0.01	-0.18	-0.13	-0.09	0.07	-0.13
No. of first flowering node		1.00	0.33	0.06*	-0.18	-0.07	-0.11	-0.19	-0.09	0.37*	0.16	0.04	-0.17	0.13	0.43*	0.33*	0.48*	0.22*	0.19	0.48*
No. of stem per plant			1.00	-0.09	0.18	0.47*	0.40*	-0.12	-0.15	-0.08	0.11	0.09	0.25*	0.35*	0.07	-0.08	-0.01	0.44*	0.47*	-0.01
Plant height (cm)				1.00	0.16	-0.20	-0.12	-0.16	-0.23*	0.15	0.22*	0.06	-0.11	-0.17	0.17	-0.04	0.04	-0.23*	0.20	0.04
No. of ridge of stem					1.00	0.12	0.01	-0.03	-0.08	-0.10	0.28*	0.34*	-0.26*	0.02	0.09	-0.44*	-0.31*	0.00	-0.04	-0.32*
Leaf length (cm)						1.00	0.86*	0.11	0.12	-0.04	0.07	-0.34*	0.38*	0.33*	-0.14	-0.09	-0.11	0.28*	0.18	-0.10
Leaf width (cm)							1.00	0.25*	-0.02	-0.19	0.04	-0.32*	0.57*	0.43*	-0.07	-0.03	-0.03	0.33*	0.22*	-0.02
Pedicel length (cm)								1.00	-0.02	-0.10	-0.07	0.03	0.32*	0.26*	0.01	-0.09	-0.06	0.21	-0.03	-0.06
Ovary diameter (cm)									1.00	0.11	0.36*	-0.22	0.00	0.05	-0.13	-0.24*	-0.27*	0.11	-0.08	-0.27*
Ovary length (cm)										1.00	0.35*	0.06	-0.16	-0.25*	0.30*	0.17	0.29*	-0.21	-0.29*	0.26*
Style length (cm)											1.00	0.06	0.01	0.07	0.11	-0.26*	-0.19	0.06	-0.10	-0.19
Pistil length (cm)												1.00	0.07	-0.07	0.17	-0.10	0.01	-0.02	-0.11	0.00
Fruit length (cm)													1.00	0.41*	0.02	-0.06	-0.03	0.33*	0.19	-0.03
Fruit diameter (cm)														1.00	0.02	-0.09	-0.03	0.38*	0.33*	-0.02
Single fruit weight(gm)															1.00	0.12	0.57*	0.23*	-0.10	0.56*
No. of fruit per plant (gm)																1.00	0.87*	0.02	0.00	0.88*
Fruit yield per plant (Kg)																	1.00	0.15	-0.07	1.00*
No. of seed per fruit																		1.00	0.12	0.15
100 seed weight (gm)																			1.00	-0.04

$p>0.05\%$; **1.** Days to 1st flowering, **2.** Number of first flowering node, **3.** Number of stem per plant, **4.** Plant height, **5.** Number of ridge of stem, **6.**Leaf length, 7**.** Leaf width, **8.** Pedicel length, **9.** Ovary length,**10.** Ovary diameter, **11**. Style length, **12.** Pistil length,**13.** Fruit length,**14.** Fruit diameter, **15.** Single fruit weight, **16.** Number of fruit plant^{-1}, **17.** Fruit yield kg plant^{-1}, **18.** Number of seed fruit^{-1}, 19**.** 100 seed weight (g.), **20.** Yield (kg/ha) seed fruit^{-1}, but they showed significant negative correlation towards pistil length. Leaf width had significant positive association with pedicel length, fruit length, fruit diameter, number of seed fruit^{-1}, 100 seed weight, and significant negative correlation towards pistil length. Pedicel length had significant positive correlation with fruit length and fruit diameter. Ovary diameter expressed significant positive correlation with style length, and significant negative correlation toward number of fruit plant^{-1}, fruit yield kg plant^{-1} and yield kg ha^{-1}. Ovary length had significant positive correlation with style length, single fruit weight, fruit yield kg plant^{-1}, yield kg ha^{-1}. But they showed significant negative correlation towards fruit diameter and 100 seed weight. Fruit length had significant association with fruit diameter and number of seed fruit^{-1}. Fruit diameter had significant correlation with number of seed fruit^{-1} and 100 seed weight. Single fruit weight had significant correlation with fruit yield kg plant^{-1}, number of seed fruit^{-1} and yield kg ha^{-1}. Number of fruit plant^{-1} had significant correlation with fruit yield kg plant^{-1} and yield kg ha^{-1}. Similar association of vine length with fruit length, fruit width, fruit weight and number of fruits plant^{-1} was reported by Tiwari and Tigga (2015), and Bharathi et al. (2005b) in spine gourd; and Ramachandran and Gopalakrishnan (1979) and Bhave et al. (2003b) in bitter gourd. Islam et al. (2009) reported similar correlation with fruit length and fruit width in bitter gourd. Rahman et al. (2011) also reported positive correlation of vine length with number of fruits plant^{-1} in teasel gourd.

The first seventh principal components gave eigen values >1, and cumulatively accounted for 0.764 the total variation (Table 2). The principal component (PC1) is related to number of stem plant^{-1} (0.10), number of ridge on stem (0.17), leaf length (0.22), leaf width (0.21), pedicel length (0.12), ovary diameter (0.15), fruit length (0.17) and fruit diameter (0.16) that explained 19.6% of total variability. The characters with greatest positive weight on second principle component (PC-2) where plant height (0.12), number of ridge on stem (0.12) and pistil length (0.11) that explained 17.1% of total variability. Principal component 3 where positive weight contributing characters were pedicel length (0.13) and number of fruit plant^{-1} (0.23) that explained 10.4% of total variability. Principle component (PC4) the characters with greatest positive contribution days to 1st flowering (0.40), plant height (0.19), number of ridge on stem (0.10), pedicel length (0.24), pistil length (0.46), fruit length (0.25) and 100 seed weight (0.12) that explained 8.6% of total variability. Principle component (PC5) the positive characters number of stem plant^{-1} (0.35), plant height (0.10), number of ridge on stem (0.16) and 100

Table 2: Principal component analysis for twenty (20) quantitative contributing characters

Variables / Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14	PC15	PC16	PC17	PC18	PC19	PC20
Days to 1st flowering	0.10	0.01	-0.10	0.40	-0.36	0.34	0.16	0.20	-0.23	-0.26	0.32	0.17	-0.30	0.07	-0.20	0.34	0.04	-0.04	-0.03	0.01
No. of first flowering node	-0.28	-0.18	-0.30	-0.15	0.09	0.01	0.31	0.08	0.25	-0.07	0.28	0.05	-0.40	0.25	0.33	-0.26	-0.35	0.02	0.02	0.01
No. of stem per plant	0.10	-0.33	-0.29	-0.07	0.35	-0.08	0.00	0.30	0.13	0.20	-0.06	0.09	0.13	-0.05	0.08	0.68	-0.07	0.09	-0.03	0.01
Plant height (cm)	-0.08	0.12	-0.29	0.19	0.10	0.52	-0.07	-0.43	-0.09	0.19	-0.23	0.06	-0.12	-0.38	0.35	0.04	-0.07	-0.03	-0.02	-0.01
No. of ridge on stem	0.17	0.12	-0.40	0.10	0.16	-0.21	-0.43	-0.12	-0.14	-0.39	0.03	0.13	0.09	-0.03	-0.22	-0.11	-0.50	0.12	0.03	0.01
Leaf length (cm)	0.22	-0.34	0.00	-0.22	-0.04	0.17	-0.40	0.17	-0.02	-0.10	0.16	0.14	0.02	-0.09	0.19	-0.16	0.11	-0.66	-0.01	0.00
Leaf width (cm)	0.21	-0.40	0.05	-0.04	-0.10	0.21	-0.35	0.01	-0.05	-0.03	0.03	-0.02	-0.09	0.17	0.19	-0.17	0.24	0.68	-0.03	-0.01
Pedicel length (cm)	0.12	-0.13	0.13	0.24	-0.35	-0.21	-0.05	-0.39	0.58	-0.03	-0.03	0.40	0.09	0.09	0.13	0.16	-0.06	-0.04	0.01	0.00
Ovary diameter (cm)	0.15	0.06	0.00	-0.44	-0.32	-0.05	0.36	-0.04	-0.36	-0.20	0.02	0.26	0.36	-0.16	0.34	0.08	-0.14	0.14	-0.01	0.00
Ovary length (cm)	-0.22	0.08	-0.25	-0.26	-0.33	0.20	-0.09	0.25	0.42	0.09	0.12	0.05	0.14	-0.46	-0.35	-0.12	0.03	0.18	-0.01	0.01
Style length (cm)	0.08	0.05	-0.45	-0.30	-0.25	0.09	0.03	-0.10	0.04	-0.07	-0.52	-0.09	-0.09	0.47	-0.18	0.06	0.20	-0.14	0.04	-0.01
Pistil length (cm)	-0.04	0.11	-0.31	0.46	-0.06	-0.27	0.06	0.44	0.01	-0.09	-0.23	0.10	0.17	-0.09	0.36	-0.27	0.32	0.00	-0.03	-0.01
Fruit length (cm)	0.17	-0.32	0.05	0.25	-0.30	0.12	0.11	0.18	-0.09	0.37	-0.23	-0.24	0.21	0.06	-0.08	-0.19	-0.55	-0.06	0.05	0.00
Fruit diameter (cm)	0.16	-0.33	-0.07	0.07	-0.02	-0.10	0.25	-0.20	0.16	-0.48	-0.03	-0.59	-0.03	-0.36	0.00	0.05	0.08	-0.04	-0.04	-0.01
Single fruit weight gm.	-0.27	-0.12	-0.33	0.09	-0.17	-0.16	-0.09	-0.29	-0.20	0.25	0.43	-0.21	0.32	0.18	0.01	0.04	0.15	-0.07	-0.39	-0.02
No. of fruit per plant gm.	-0.39	-0.17	0.23	-0.01	0.03	0.09	-0.05	0.10	-0.04	-0.28	-0.36	0.16	-0.01	0.00	-0.06	0.03	-0.14	-0.01	-0.69	-0.06
Fruit yield plant Kg./ plant	-0.45	-0.22	0.04	0.04	-0.07	-0.01	-0.10	-0.03	-0.13	-0.13	-0.06	0.02	0.10	0.00	-0.01	0.09	0.01	-0.01	0.48	-0.67
No. of seed per fruit	0.05	-0.34	-0.11	-0.04	-0.04	-0.40	0.14	-0.15	-0.29	0.27	-0.11	0.32	-0.42	-0.31	-0.28	-0.15	0.13	0.00	-0.02	0.00
100 seed weight gm	0.09	-0.22	-0.07	0.12	0.40	0.32	0.38	-0.14	0.06	-0.10	0.05	0.30	0.41	0.13	-0.31	-0.28	0.16	0.00	0.04	-0.01
Yield kg per ha	-0.44	-0.22	0.05	0.04	-0.06	0.00	-0.09	-0.04	-0.13	-0.13	-0.08	0.03	0.10	0.01	0.00	0.07	0.03	-0.01	0.36	0.74
Statistics	**PC1**	**PC2**	**PC3**	**PC4**	**PC5**	**PC6**	**PC7**	**PC8**	**PC9**	**PC10**	**PC11**	**PC12**	**PC13**	**PC14**	**PC15**	**PC16**	**PC17**	**PC18**	**PC19**	**PC20**
Standard deviation	1.981	1.847	1.444	1.311	1.280	1.164	1.072	0.949	0.848	0.797	0.778	0.727	0.677	0.555	0.475	0.367	0.347	0.270	0.083	0.031
Proportion of variance	0.196	0.171	0.104	0.086	0.082	0.068	0.058	0.045	0.036	0.032	0.030	0.026	0.023	0.015	0.011	0.007	0.006	0.004	0.000	0.000
Cumulative proportion	0.196	0.367	0.471	0.557	0.639	0.707	0.764	0.809	0.845	0.877	0.907	0.934	0.957	0.972	0.983	0.990	0.996	1.000	1.000	1.000
Eigen Values	3.926	3.411	2.085	1.718	1.638	1.356	1.149	0.901	0.718	0.636	0.606	0.528	0.458	0.308	0.226	0.135	0.120	0.073	0.007	0.001

seed weight (0.40) that explained 8.2% of total variability. Principle component (PC6) the positive greatest contributing characters days to 1^{st} flowering (0.36), plant height (0.52), leaf length (0.17), leaf width (0.21), fruit length (0.12), ovary length (0.20), and 100 seed weight (0.32) that explained 6.8% of total variability. Principle component (PC7) the positive contributing characters days to 1^{st} flowering (0.16), number of 1^{st} flowering node (0.31), ovary diameter (0.36), fruit length (0.11), fruit diameter (0.25), number of seed fruit^{-1} (0.14) and 100 seed weight (0.38) that explained 5.8% of total variability. These findings revealed that two first components are related to yield components of spine gourd and a wide range of diversity for most of the traits, along with some accessions with unique characters were found which could help to identify genotypes with suitable traits to be used in hybridization programme for breeding to broaden genetic base. The first two components contributing 63% of the variance were plotted to observe the relationships between the clusters. The result of this analysis confirmed the grouping pattern which was found by cluster analysis. All clusters are clearly separated from each other.

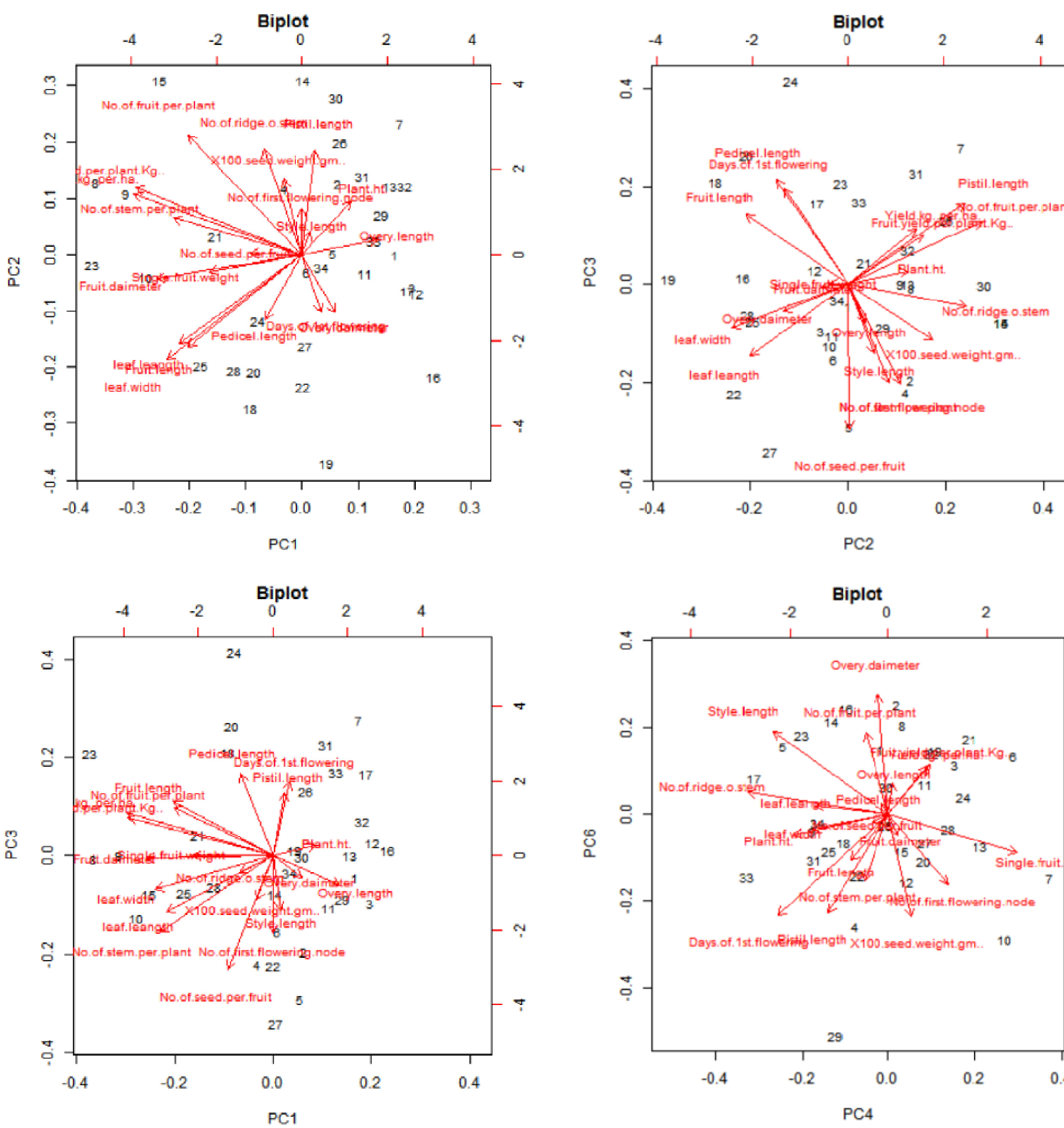

Figure 1: Constriction for different principal component

The plot defined by the PC1 and PC2 distinguished two groups of characters fig.1 the groups was positively correlated with axes two (PC2) and composed of days to 1st flowering, number of stem, number of ridge on stem, leaf length (cm), leaf width (cm), pedicel length (cm), ovary diameter (cm), style length (cm), fruit length (cm), fruit diameter (cm), no of seed fruit^{-1} and 100 seed weight (g.) was positively correlated to both axes (PC1 and PC2). This character help in genotypes selection based on PC values with high yielding potential. Screen plot had lay out between eigen value and principal component and showed % of total variation fig.2: between them. First principal component showed highest variation 19.6 % followed by 17.1% (second PC), 10.4% % (third PC), 8.6% (fourth PC), 8.2% (fifth PC), 6.8% (six PC) 5.8% (seventh PC), 5.8% (eighth PC) 4.5% (ninth PC), 3.6% and (tenth PC) 3.2%. Total variation of seventh PC was recorded 76.4%. Semi curve line obtained after third PC with little variation observed in each PC indicated that maximum variation was found in first PC; therefore selection from this PC may be desirable. Rotated component matrix revealed that the first principal component which accounted for highest variation (19.6%) was mostly related with traits such as number of ridge on stem, leaf length, leaf width, pedicel length, ovary diameter, fruit length and fruit diameter. The results also suggest importance of these traits in development of high yielding varieties. Taken together, results showed a significant amount of genetic variability among the tested genotypes, and suggest there usefulness in breeding program.

In order to maintain, evaluate and utilize germplasm effectively, it is important to investigate the extent of available genetic diversity (Mohammadi 2003). Considered dandrogram using agglomerative clustering method based morphological characterization as an important step in description and classification of crop germplasm because a breeding program mainly depends upon the magnitude of genetic variability. The genotypes of each cluster are shown in Table 3, Table 4 and Figure 3: cluster I consisted of - 11 genotypes Indira Kankoda-1, KRISNAPUR, PK-49, RMF-P-4, NDM-1, NDM-5, RMDSG-1, AMBIKA K12-1, AMBIKA 13-5, AMBIKA13-6 and NDM-4, cluster II of 8 genotypes PK-5, PK-9, PK-26, PK-34, PK-35, PK-46, RMF-1, and PK-33 cluster III of 12 genotypes RMF-17, RMF-27, RMF-7-P-1, PHULE MD 5-1, RAIGARH, NDM-2, NDM-3, DHARAMJAYGARH, RMF- G-39, AJSG-3, AJSG-4 and AJSG-5 and cluster IV of 2 genotypes PHULE MD-5-2 and RMF-G-49. The results show that for days to first flowering (47 days) cluster I has the highest mean (69 days) and cluster III has the lowest mean (47 days). Number of stem plant^{-1} highest cluster I has the highest mean (14.8) and cluster III has the lowest mean (2.8). Plant height cluster IV has the highest mean (316 cm) and cluster II has the lowest mean (131 cm). Fruit length cluster II has the highest mean (6.4cm) and cluster I has the lowest mean (3 cm). Fruit diameter cluster II has the highest mean (3.98 cm) and cluster III has the lowest mean (2.05cm) Single fruit weight cluster I has highest mean (21g) and cluster II has the lowest mean (10.8g). Number of fruit plant^{-1} cluster I has highest mean (150 fruits) and cluster IV has the lowest mean (54 fruits). Fruit yield g plant^{-1} cluster I has highest mean (2691g) and cluster IV has the lowest mean (702g). Cluster I has highest mean fruit yield (5982 kg) and cluster II has lowest mean (1558.5 kg). The germplasm represented a wide range of diversity for most of the traits evaluated. The similarity result found in Prasad et al. (2001) genetic variability in bitter gourd. In present no solid research work has been done in spine gourd crop so multivariate analysis through

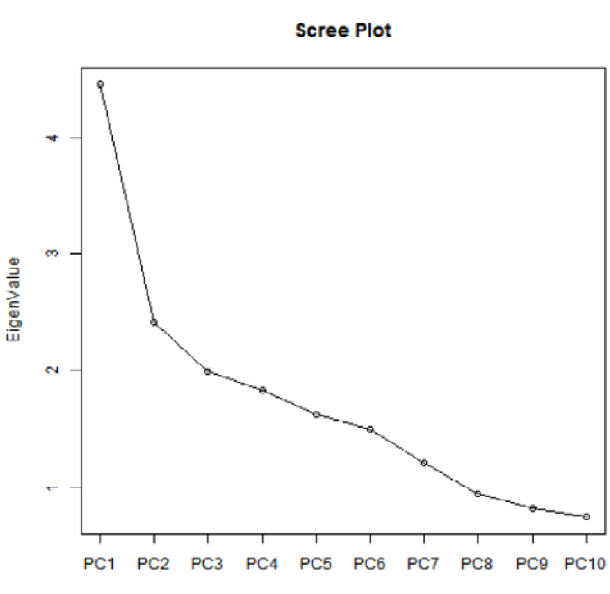

Figure 2: Scree plot constructed for 10 principle components

Table 3: Cluster of germplasm accession with their composition

Cluster	Number of genotypes	Cluster members
I	11	Indira Kankoda-1, RISHNAPUR , PK49, RMF-P-4, NDM-1, NDM-5, RMDSG-1,AMBIKA-K-12-1, AMBIKA 13-5, AMBIKA 13-6, NDM-4
II	8	PK -5, PK -9, PK -26, PK-34, PK-35, PK -46,RMF-1, PK -33
III	12	RMF-17, RMF-27,RMF-7-P-1, PHULLE MD-5-1, RAIGARH,NDM-2, NDM-3, DHARMJAYGARH, RMF-G-39, AJSG-3, AJSG-4, AJSG-5
IV	2	PHULLE MD-5-2, RMF-G-49

Table 4: Mean and standard deviation in four cluster group in spine gourd germplasm

Character	Cluster I	Cluster II	Cluster III	Cluster IV
Days to1st.flowering	52.18 ±4.4	55.25 ± 6.2	52.92 ± 6.19	66.5 ± 0.71
No. of first flowering node	18 ± 5.22	11.38 ± 3.2	14.25 ± 4.81	9.5 ± 2.12
No. of stem per plant	9.22 ± 3.22	8.4 ± 3.26	6.33 ± 1.7	5.5 ± 0.71
Plant height (cm)	243.55 ± 34.81	206.25 ± 50.3	239.5 ± 46.72	305 ± 15.56
No. of ridge of stem	4.64 ± 0.5	4.38 ± 0.52	4.5 ± 0.52	5 ± 0
Leaf length (cm)	7.21 ± 0.82	7.58 ± 1.36	6.03 ± 1.81	6.8 ± 0.57
Leaf width (cm)	6.52 ± 0.91	7.15 ± 1.04	5.24 ± 0.71	6.25 ± 0.21
Pedicel length (cm)	2.38 ± 0.49	2.96 ± 0.33	2.34 ± 0.34	2.4 ± 0.91
Ovary diameter (cm)	0.64 ± 0.11	0.72 ±0.06	0.67 ± 0.12	0.66 ± 0.2
Ovary length (cm)	1.89 ± 0.26	1.53 ± 0.22	1.84 ± 0.27	1.98 ± 0.28
Style length (cm)	0.88 ± 0.22	0.79 ± 0.12	0.78 ± 0.14	1.01 ± 0.16
Pistil length (cm)	0.5 ± 0.9	0.48 ± 0.9	0.56 ± 0.1	0.57 ± 0.7
Fruit length (cm)	4.27 ± 1.03	4.87 ± 0.76	3.72 ± 0.45	4.24 ± 0.06
Fruit diameter (cm)	3.21 ± 0.23	3.44 ± 0.34	2.54 ± 0.4	2.58 ± 0.37
Single fruit weight (g)	18.63 ± 1.36	14.38 ± 2.49	15.88 ± 1.9	15.55 ± 3.61
No. of fruit per plant	112.91 ± 25	90 ± 22.68	112 ± 20.36	54 ± 0
Fruit yield (kg/plant)	2088.05 ± 423.21	1292.62 ± 368.32	1774.55 ± 379.47	839.7 ± 194.74
No. of seed per fruit	18.34 ± 2.47	18.84 ± 2.64	15.82 ± 3.39	15 ± 1.41
100 seed weight (g)	7.35 ± 0.59	7.58 ± 1.01	7.01 ± 0.81	6.53 ±0.02
Yield (kg/ha)	4641.7 ± 940.78	2920.84 ± 862.76	3944.77 ± 843.56	1866.6 ± 432.89

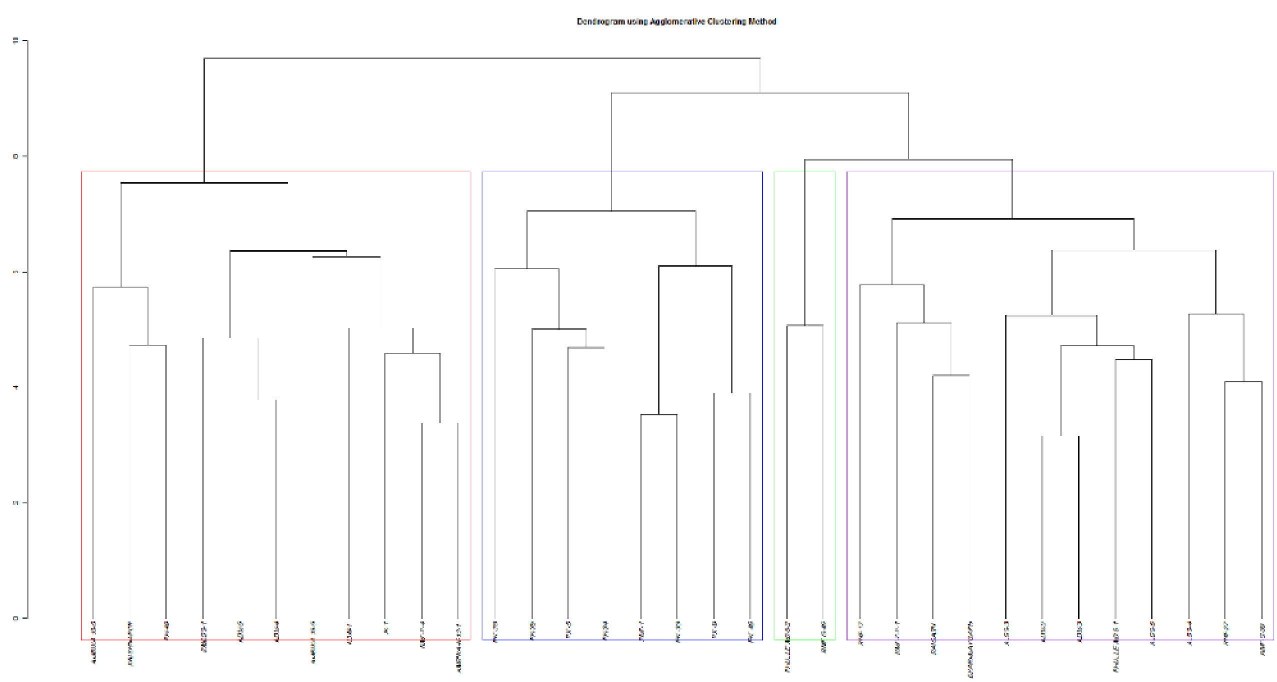

Fig. 3: Clustere analysis for quantitative traits in spine gourd

better performing genotypes should be included in further breeding program. From the present research work, it is concluded that spine gourd genotypes displayed a wide range of variation for most of the traits studied. Fruit yield was significantly and positively correlated with number of first flowering node, ovary length, single fruit weight, number of fruit per plant and fruit yield kg per plant, these characters are effective parameter for selection of parents. Leaf length, leaf width, number of ridge on stem, fruit length, fruit diameter, and ovary diameter contributed highest for fruit yield revealed by PCA. Grouping genotypes in clusters revealed that for expatiation of heterosis in spine gourd crossing between the genotypes of different cluster will be done. The dendogram provided an overall pattern of variation as well as the degree of relationship among genotypes.

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करतोली के 33 जीन प्ररूपों को सम्मिलित वर्तमान अध्ययन अनुवांशिक मापदंडों सहसम्बन्ध विश्लेषण, प्रमुख घटक विश्लेषण एवं समूह विश्लेषण का परीक्षण किया गया। प्रति पौध फल उपज का 43 सहसम्बन्ध विश्लेषण एवं फल उपज घटकों जैसे प्रथम पुष्पन की

प्राथमिक गांठ संख्या, अंडाशय की लम्बाई, एकल फल भार और प्रति पौध फलों की संख्या के बीच सकारात्मक सम्बन्ध के साथ जुड़ा हुआ था। करतोली के जीन प्रारूपों के बीच अनुवांशिक विविधता का प्रमुख घटक विश्लेषण के माध्यम से निष्पादित किया गया। जिसमें पहले सात घटक अक्षों का विचलन के लिए 76.4 प्रतिशत भिन्नता के लिए जिम्मेदार पाया गया समूह विश्लेषण में समूह 3 में बारह जीन प्रारूप, समूह 1 में ग्यारह जीन प्रारूप, समूह 2 में आठ जीन प्रारूप एवं समूह चार में केवल दो जीन प्रारूप थे। प्रमुख घटक और समूह विश्लेषण के लिए मुख्य घटक अंकों से प्राप्त चार अलग–अलग समूहों में समूहीकृत जीन प्रारूप पाये गये। करतोली की फसल पर आजतक कोई गहन अनुसंधान कार्य नहीं किया गया है, जिससे सहसम्बन्ध विश्लेषण में जो महत्वपूर्ण सामग्री का सकारात्मक लक्षणों का चयन कर पादप प्रजनन कार्यक्रम में आगे प्रयोग किया जा सके साथ ही साथ करतोली एक अत्यधिक पर–परागित फसल है, अतः इसके लिए सूक्ष्म कटाओं या सूक्ष्म प्रसार के माध्यम प्रसारण लाभकारी सिद्ध होगा।

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