Electronic Journal of Plant Breeding, 8(3): 857-864 (September 2017) DOI: 10.5958/0975-928X.2017.00140.5
ISSN 0975-928X

Research Article

Association and principal component analysis of yield and its components in cultivated cotton

Abasianyanga Isong, P. Amala Balu and P. Ramakrishnan
Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore – 641003, India
E-mail: isongplus@yahoo.com

(Received: 28 May 2017; Revised: 27 Aug 2017; Accepted: 30 Aug 2017)

Abstract
Yield is a complex quantitative character that is controlled by many small genes. For effective and simultaneous selection to improve upon yield of cotton, interaction and contribution of each of the trait parameters has to be understood. The study to understand the relationship of yield components was conducted on sixty hybrids obtained from a cross of ten *G. hirsutum* and six *G. barbadense* in a Line x Tester fashion. The study revealed that most of the components were positively correlated amongst each other both genotypically and phenotypically. Number of bolls per plant, Number of sympodial branches per plant and boll weight had positive and high significant correlations with seed cotton yield per plant. In all cases phenotypic coefficient was greater than genotypic coefficient suggesting environmental interference. Partitioning the association into direct and indirect effects indicated that seed index had the highest direct effect on seed cotton yield. For indirect selection, seed index, number of monopodia, number of seeds/boll will be more reliable and 2.5% span length, bundle strength, elongation percent and micronaire also are more reliable for indirect selection for fibre quality in cotton. Six Principal components showed Eigen value of more than one with an accumulated variability of 70.39%. The Principal component with the highest variability was mostly related to seed cotton yield, uniformity ratio, boll weight, number of sympodia, number of bolls/plant and plant height.

Key words
Path analysis, Cotton, principal component, hybrid, correlation, yield

Introduction

Global textile industry depends on both natural and artificial sources of fibre for production. Natural fibre is either from animal or plant, however 70 – 80% of natural fiber is derived from cotton plant (*Gossypium spp*). Cotton which is regarded as king of fiber provides lint as raw material to the textile industry. It is cultivated in over 80 countries of the world with annual production of over 20 million tons (Farasat *et al*., 2014) thereby contributing to trade and investment of those countries and improving on their GDP. Cultivated cottons are mostly diploid and tertraploid. The tertraploid cotton (*G. hirsutum and G. barbadense*) contributes about 98% fiber to the natural fiber demand. Interspecific hybrids of *G. hirsutum* and *G. barbadese* are mostly employed to increase yield and quality in cotton. Hybrid production is one such method to increase yield per hectare. Hybrids occupy 45% of total area and contribute 55% to the total production of cotton in India. Optimizing yield in interspecific crosses of cultivated cotton is yet to be actualized. To optimize yield potential, Thiyagu *et al.* (2010) reiterated that understanding the relationship among different characters and knowledge of the direct contribution of the characters to seed cotton yield will be highly important in formulating a breeding program. Performance and positive association of seed cotton yield with its components have been discovered in *G. hirsutum* genotypes (Mendez-Natera *et al*., 2012, Farooq *et al*., 2014). Yield is known to be a complex quantitative character controlled by polygens. Hence, it is a product of multiplicative interaction among its components and highly sensitive to environmental fluctuation (Vernier and Dansi, 2000; Obiokoro, 2005). Yield is the major objective in most selection programs, and direct selection as such could be misleading. The knowledge of direct and indirect effects of yield components is necessary to reveal which effect is important (Isong *et al*., 2013). Correlation coefficient is known to determine the relationship between components necessary for selection, however when more characters are involved, the indirect association between characters become more complex. Path coefficient analysis is found to be useful in revealing the relationship among traits whereby suitable for effective selection of complex traits in cotton (Liaqat *et al*., 2015, Iqbal *et al*., 2006). Therefore, the study of direct and indirect association will help in understanding the yield components and form the basis for selection to improve yield. Principal component analysis which shows pattern of existing variation between hybrids can be used to inform on genetically diverse but agronomically important genotype. Saeed *et al.* (2014) suggested a grouping of each genotype to a single group by replicating significance of huge contributor to the entire variation at every axis of variation. Therefore, this study was designed to explore the relationship of seed cotton yield with its components and to partition the relationship into direct and indirect effects. Also, it is to explore grouping pattern and indicate genetically diverse but agronomically

Electronic Journal of Plant Breeding, 8(3): 857-864 (September 2017) DOI: 10.5958/0975-928X.2017.00140.5
ISSN 0975-928X

important interspecific hybrids of cultivated cotton.

Materials and methods

The Study Location: The investigation to understand the components association with seed cotton yield and the principal components was carried out during the summer season of 2016. The field work was done in experimental fields of Cotton department, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore

Experimental Design: Hybrids derived from sixteen parents by Line x Tester design were the experimental materials. Ten *G. hirsutum* genotypes (TCH1777, MCU9, TCH1716, MCU7, TCH1819, COD-5-1-2, African1-2, VS-9-S11-1, TCH1705-101, KC2) were crossed with six *G. barbadense* genotypes (TCB26, TCB37, TCB209, CCB36, DB3, Suvin) to have a total of 60 hybrids for the experiment. They were evaluated in a Randomized Block Design with three replications. Two rows of hybrids were planted at a spacing of 90cm between rows and 60cm between plants during February 2016. Basic agronomic practices were carried out as recommended, field observations and data collection were done and recording was on ten selected plants in each entry for seed cotton yield (g), plant height (cm), number of bolls per plant, number of sympodia branches per plant, number of monopodia branches per plant, boll weight (g), number of seeds per boll, ginning percentage, lint index and seed index. Days to flowering, days to 50% flowering and days to first bursting were observed in plot basis. The quality traits like 2.5% span length (mm), micronaire, bundle strength, elongation percentage and uniformity ratio were obtained using ginned lint on a High Volume Instrument.

Statistical Analysis: The data obtained were subjected to statistical analysis for correlations and path analysis by the method suggested by Dewey and Lu (1959) using the AGRISTAT statistical analyses software. Principal Component Analysis (PCA) also was carried out on the mean data using IBM SPSS v20.

Results and Discussion

Genotypic and phenotypic correlation coefficients for different yield components are presented in table 1, the contribution of each of the components to yield are indicated in Table 2. The highlighted diagonal values indicate the direct effect of each of the components to yield, the indirect contribution to the seed cotton yield per plant by each component are the horizontal and vertical values in Table 2. Table 3 shows the Principal Components for 18 characters in 60 hybrids of cultivated cotton, and the scree plot (Fig. 1) further highlighted the partitioning of the principal components

Correlation analysis: Correlation coefficient as indicated in Table 1 shows that all the characters were positively associating with seed cotton yield per plant both phenotypically and genotypically except days to flowering, 2.5% span length and number of monopodia per plant. Other components also had positive and significant correlation amongst each other, however number of bolls per plant, number of sympodial branches and boll weight had positive and high significant correlation with seed cotton yield per plant

Path analysis: Correlation coefficient only indicates inter-relationship of different characters and does not account for the information on cause and effect. Consequently path analysis is employed to identify the basic index for selection. Here it was used to partition the observed correlations into undeviating (direct) and deviating (indirect) effects of cotton components. According to Table 2, not all the direct effects were less than 1. Seed index demonstrated the highest direct and positive impact on the seed cotton yield per plant. This was followed by days to 50% flowering, number of monopodia and number of bolls per plant. . Similar results were reported by Reddy *et al.* (2015), Chitti *et al*. (2014), Rumesh *et al*. (2014), Abdullah *et al.* (2016) and Vinodhana *et al*. (2013). However, in their reports, boll weight, lint index, and number of seeds per boll also showed positive direct effect. Earlier work by Latif *et al*. (2015) indicated similar positive direct effect by number of bolls per plant, however it was not on hybrids, and the component recorded the highest direct positive effect. Other components like ginning outturn, boll weight, bundle strength, elongation percent and micronaire also showed positive but low direct effects on cotton yield per plant. The highest indirect and positive effect was recorded by seed index through boll weight. This was followed by seed index through lint index, 2.5% span length through elongation percent, seed index through number of sympodia per plant, seed index through plant height and number of seeds per boll accordingly. Seed index had the highest value and number of positive indirect effects on yield, accordingly from our investigation it is has illustrated good positive direct effect on yield *via* boll weight. Indirect effects by 2.5 per cent span length through elongation percent, number of seed per boll through days to first bursting, number of monopodia per plant through uniformity ratio was also positive. Based on path analysis, ginning outturn, bundle strength boll weight, elongation percent and micronaire were more reliable for direct selection for seed cotton yield. However, seed index, number of monopodia, number of seeds per boll showed more reliability for indirect selection, and 2.5% span length, bundle strength, elongation percent and micronaire also showed reliability for indirect selection for fibre quality in cotton. These observations were also noticed by Thiyagu *et al.* (2010) in his work on interspecific crosses of cotton. The positive significant correlation with seed cotton yield by most of the parameters as revealed by path analysis was mainly due to their indirect effects through other components.

Principal components analysis: Khan *et al*. (1999) and Khan (2003) working on yield and its components discovered high genetic variability amongst the components in cotton. To indicate the pattern of this variability existing in the population and to possibly group them into components, mean data of sixty cotton hybrids were subjected to principal component (PC) analysis. Eighteen PCs that were realized, only six described eigen value of more than one and contributed about 70.39% of accumulative variation among the hybrids. The six PCs is therefore used to explain the total variation and the grouping of the PCs, the remaining 12 PCs showed less than 1 eigen values and were less significant.

The first PC explained the highest variability of 22.54% and was most related to seed cotton yield, uniformity ratio, boll weight, number of sympodia, number of bolls per plant and plant height. The second and third PCs had variability of 13.1% and 10.7% respectively and were more associated with days to first bursting, days to flowering, 2.5% span length and seed index. The rest PCs were more associated with bundle strength, number of seeds per boll and days to 50% flowering.

References

Abdullah M., Numan, M., Shafique, M. S., Shakoor, A., Rehman, S. and Ahmad, M. I. 2016. Genetic variability and interrelationship of various agronomic traits using correlation and path analysis in Cotton (*Gossypium hirsutum*L.*). Academia Journal of Agricultural Research* **4**(6): 315-318

Chitti B. K., Rajesh, S.P., Katageri, I. S., Sekhar, L and Khadi, B.M. 2014. Direct and indirect effect of various traits on seed cotton yield in single, double and three way cross derivatives in upland cotton (*Gossypium arboreum* L.). *Journal of Cotton Research and Development*. **28**(2): 195- 200

Dewey, D.R and Lu, K.H. A. 1959. Correlation and path coefficient analysis of components of crested wheat grass seed production. *Agronomy Journal*. **51**(9): 515-518

Farasat, S., Jahanzeb, F., Abid, M/, Muhammad, R, Tassawar, H. & Abdul, M. 2014. Assessment of genetic diversity for Cotton leaf curl virus (CLCuD), fiber quality and some morphological traits using different statistical procedures in *Gossypium hirsutum* L. *Australian Journal of Crop Science* **8**(3): 442–447.

Farooq J., Anwar M, Riaz M., Farooq A., Mahmood A., Shahid M. T. H., Rafiq S. and F. Ilahi F. 2014. Correlation and path coefficient analysis of earliness, fiber quality and yield contributing traits in cotton (*Gossypium hirsutum L.*). *The Journal of Animal & Plant Sciences,* **24**(3): 781-790

Isong, A., Eka, M. J. and Nwankwo, I. I. M. 2013. Correlations and Path Analysis of Yam (*Dioscorea rotundata* Poir) yield and yield Components. *International Journal of Applied Research and Technology.* **2**(11): 65 – 71.

Khan, N.U. 2003. Genetic analysis, combining ability and heterotic studies for yield, its components, fibre and oil quality traits in upland cotton (*G. hirsutum* L.). PhD Thesis. Sindh Agric. Univ. Tandojam, Pakistan.

Khan, N.U., H.K. Abro, M.B. Kumbhar, G. Hassan and M. Khan. 1999. Exploitation of heterosis can combat Cotton Leaf Curl Virus (CLCV) incidence in cotton (*G. hirsutum* L.). *The Pak. Cottons.* **43**(3&4): 21-33.

Kumari Vinodhana, N., Gunasekaran, M and Vindhyavarman, P. 2013. Genetic studies of variability, correlation and path coefficient analysis in cotton genotypes. *Intl J. Pure and App. Biosci.* **1**(5): 6-10

Latif1 A., Bilal M., Hussain S. B and Ahmad F. 2015. Estimation of genetic divergence, association, direct and indirect effects of yield with other attributes in cotton (*Gossypium hirsutum* L.) using biplot correlation and path coefficient analysis. *Intl Journal for Trop Pl Res.*, **2**(2): 120 – 126

Méndez-Natera, J. R., A. Rondón, J. Hernández and J.F. Merazo-Pinto. 2012. Genetic studies in upland cotton. III. Genetic parameters, correlation and path analysis. *Sabrao. J. Breeding & Genetics* **44**(1): 112 – 128

Obiokoro, O.G. 2005. Agrometeorology. Dunkwu Publishers, Onitsha, pp. 24-30

Reddy K. B., Reddy V. B., Ahmed M. L., Naidu T.C.M. and Srinivasarao V. 2015. Correlation and Path Coefficient Analysis in Upland Cotton (*Gossypium hirsutum* L.). *Int. J. Pure App. Biosci.* **3**(3): 70-80

Rumesh Ranjan., Sangwan, R.S., Siwach, S.S., Sangwan, O and Sah, M.K. 2014. Correlation and path analysis studies in *Gossypium arboreum* L. *Journal of Cotton Research and Development*. **28**(1): 37-39

Saeed F, Farooq J, Mahmood A, Riaz M, Hussain T, Majeed A. 2014. Assesment of genetic diversity for cotton leaf curl virus (CLCuD), fiber quality and some morphological traits using different statistical procedures in Gossypium hirsutum L. *Australian Journal of Crop Sciences* **8**(3): 442-447

Thiyagu K, Nadarajan N, Rajarathinam S, Sudhakar D, Rajendran K. 2010. Association and path analysis for seed cotton yield improvement in inter-specific crosses of cotton (Gossypium spp). *Electron. J. Plant Breed*. **1**(4): 1001-1005.

Vernier, P. and Dansi, P. 2000. Participatory assessment and famers' knowledge on yam varieties (D. *rotundata* and D. *cayenensis*) in Benin. A paper presented at the ISTRC 2000 Symposium, Tsukuba, Ibaraki, Japan, Sept. 10-16 200, pp. 1-17

Electronic Journal of Plant Breeding, 8(3): 857-864 (September 2017)
ISSN 0975-928X
DOI: 10.5958/0975-928X.2017.00140.5

Table 1. Genotypic and Phenotypic correlation among 60 hybrids of *G. hirsutum* x *G. barbadense*

		DFF	DFB	PH	NBPP	NSPP	NMPP	BW	GP	LI	SI	2.5%SL	UR	BS	E%	FF	NSPB	SCYPP
DF	p	0.215	0.541**	0.198	-0.024	-0.005	0.131	-0.583**	0.041	-0.295*	-0.392**	-0.070	-0.298*	-0.093	-0.521**	-0.236	-0.349**	-0.040
	g	0.175	0.299*	0.011	-0.006	-0.100	0.114	-0.060	0.041	-0.193	-0.155	-0.036	-0.106	0.016	-0.094	-0.130	-0.001	-0.023
DFF	p	1.00	0.266*	0.283*	0.051	0.165	0.225	0.100	0.279*	0.138	-0.036	0.085	-0.298*	-0.020	-0.553**	0.028	0.587**	0.021
	g	1.00	0.218	-0.005	0.064	-0.062	0.156	0.003	-0.028	-0.019	-0.043	0.017	-0.053	-0.113	-0.125	0.097	0.200	0.003
DFB	p		1.00	0.163	-0.078	-0.083	0.425**	-0.513**	0.222	-0.050	-0.161	0.335**	-0.083	-0.092	-1.354**	-0.288	-0.549**	0.086
	g		1.00	0.042	-0.089	-0.053	0.175	-0.099	-0.008	-0.058	-0.085	0.177	-0.236	0.020	-0.240	-0.008	-0.136	0.052
PH	p			1.00	0.688**	0.979**	0.444**	0.477**	-0.087	0.378**	0.409**	0.199	1.067**	-0.479**	0.004	0.379**	0.071	0.341**
	g			1.00	0.508**	0.898**	0.321*	0.096	-0.043	0.326**	0.346**	0.042	0.283*	-0.237	0.074	0.224	-0.163	0.249
NBPP	p				1.00	0.852**	0.323*	0.397**	0.180	0.342**	0.269*	0.144	0.364**	-0.249	0.024	0.235	0.372**	0.365**
	g				1.00	0.570**	0.258*	0.232	0.104	0.246	0.212	0.070	0.156	-0.138	0.024	0.155	0.152	0.350**
NSPP	p					1.00	0.424**	0.616**	-0.151	0.420**	0.522**	0.231	1.206**	-0.589**	-0.042	0.434**	0.197	0.407**
	g					1.00	0.349**	0.119	-0.062	0.320*	0.355**	0.028	0.242	-0.211	0.081	0.200	-0.124	0.270*
NMPP	p						1.00	0.306*	-0.182	0.155	0.086	0.508**	0.571**	-0.303*	-0.375**	0.006	0.170	-0.033
	g						1.00	0.045	-0.207	0.030	0.125	0.183	0.101	-0.130	-0.048	-0.035	0.046	-0.020
BW	p							1.00	-0.498**	0.785**	0.966**	0.224	0.291*	0.074	0.444**	0.408**	0.542**	0.522**
	g							1.00	-0.148	0.393**	0.475**	0.067	0.025	0.029	0.035	0.084	0.496**	0.302*
GP	p								1.00	0.277*	-0.380*	-0.513**	0.175	-0.077	0.764**	0.342*	-0.027	0.108
	g								1.00	0.259*	-0.221	-0.075	-0.029	0.007	0.001	0.025	0.232	0.047
LI	p									1.00	0.959**	0.359**	0.615**	-0.069	0.378**	0.374**	0.157	0.360**
	g									1.00	0.705**	0.123	0.142	0.026	0.040	0.193	0.042	0.236
SI	p										1.00	0.360**	0.353**	0.009	0.010	0.328*	-0.161	0.266*
	g										1.00	0.204	0.123	-0.037	0.056	0.120	-0.103	0.217
2.5%SL	p											1.00	-0.59**	0.123	-1.32**	-0.017	-0.45**	-0.154
	g											1.00	-0.138	0.116	-0.38**	0.021	0.009	-0.108
UR	p												1.00	-0.186	1.356**	0.088	-0.132	0.628**
	g												1.00	0.049	0.181	-0.110	-0.016	0.238
BS	p													1.00	0.075	-0.61**	0.069	0.152
	g													1.00	-0.097	-0.314*	0.088	0.086
E%	p														1.00	0.231	0.550**	0.101
	g														1.00	0.086	-0.133	0.039
FF	p															1.00	0.093	0.273
	g															1.00	-0.005	0.176
NSPB	p																1.00	0.171
	g																1.00	0.089

Table 2. Path analysis of some components in cultivated cotton

	DF	DFF	DFB	PH	NBPP	NSPP	NMPP	BW	GP	LI	SI	2.5%SL	UR	BS	E%	FF	NSPB	SCYPP
DF	**-0.263**	0.426	-0.486	-0.226	-0.040	0.000	0.254	-0.102	0.042	0.962	-1.394	0.116	0.068	-0.067	-0.105	-0.049	0.821	-0.040
DFF	-0.057	**1.983**	-0.239	-0.323	0.085	-0.015	0.435	0.018	0.283	-0.451	-0.127	-0.139	0.068	-0.014	-0.111	0.006	-1.379	0.021
DFB	-0.142	0.527	**-0.899**	-0.186	-0.128	0.007	0.821	-0.089	0.224	0.163	-0.573	-0.552	0.019	-0.066	-0.272	-0.060	1.291	0.086
PH	-0.052	0.561	-0.146	**-1.140**	1.136	-0.087	0.858	0.083	-0.088	-1.235	1.454	-0.328	-0.244	-0.345	0.001	0.078	-0.166	0.341
NBPP	0.006	0.102	0.070	-0.785	**1.650**	-0.076	0.626	0.069	0.182	-1.115	0.956	-0.236	-0.083	-0.179	0.005	0.049	-0.875	0.365
NSPP	0.001	0.327	0.075	-1.116	1.407	**-0.089**	0.821	0.107	-0.153	-1.370	1.858	-0.380	-0.275	-0.424	-0.008	0.090	-0.464	0.407
NMPP	-0.035	0.446	-0.382	-0.506	0.534	-0.038	**1.935**	0.053	-0.184	-0.504	0.306	-0.836	-0.130	-0.218	-0.075	0.001	-0.401	-0.033
BW	0.153	0.199	0.461	-0.544	0.656	-0.055	0.591	**0.174**	-0.505	-2.564	3.438	-0.368	-0.066	0.053	0.089	0.084	-1.274	0.522
GP	-0.011	0.553	-0.199	0.099	0.297	0.014	-0.352	-0.087	**1.013**	-0.903	-1.350	0.844	-0.040	-0.056	0.154	0.071	0.062	0.108
LI	0.078	0.274	0.045	-0.431	0.564	-0.037	0.299	0.137	0.280	**-3.265**	3.414	-0.590	-0.140	-0.050	0.076	0.077	-0.370	0.360
SI	0.103	-0.071	0.145	-0.466	0.443	-0.047	0.167	0.168	-0.384	-3.132	**3.558**	-0.593	-0.081	0.007	0.002	0.068	0.378	0.266
2.5%SL	0.019	0.168	-0.302	-0.227	0.237	-0.021	0.982	0.039	-0.520	-1.171	1.282	**-1.645**	0.134	0.089	-0.266	-0.003	1.051	-0.154
UR	0.078	-0.590	0.075	-1.217	0.601	-0.108	1.104	0.051	0.177	-2.006	1.258	0.967	**-0.228**	-0.134	0.273	0.018	0.310	0.628
BS	0.024	-0.039	0.083	0.546	-0.411	0.053	-0.586	0.013	-0.078	0.227	0.032	-0.203	0.042	**0.720**	0.015	-0.125	-0.161	0.152
E%	0.137	-1.097	1.217	-0.005	0.040	0.004	-0.725	0.078	0.774	-1.235	0.034	2.178	-0.310	0.054	**0.201**	0.048	-1.293	0.101
FF	0.062	0.055	0.259	-0.432	0.387	-0.039	0.011	0.071	0.347	-1.219	1.166	0.027	-0.020	-0.436	0.047	**0.207**	-0.218	0.273
NSPB	0.092	1.163	0.494	-0.080	0.614	-0.018	0.330	0.095	-0.027	-0.514	-0.572	0.736	0.030	0.049	0.111	0.019	**-2.351**	0.171

Table 3. Eigen values, Variability and cotton components that contributed to the Eighteen components

Statistical variables	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14	PC15	PC16	PC17	PC18
Eigen value	4.058	2.352	1.932	1.654	1.386	1.288	.973	.921	.753	.650	.519	.481	.368	.270	.225	.098	.046	.027
Variability (%)	22.542	13.067	10.735	9.189	7.703	7.154	5.405	5.117	4.182	3.611	2.882	2.673	2.043	1.498	1.248	.545	.256	.151
Cumulative (%)	22.542	35.609	46.343	55.533	63.235	70.390	75.794	80.911	85.093	88.704	91.587	94.259	96.302	97.801	99.049	99.593	99.849	100.000
Traits																		
DF	-0.2	**0.453**	-0.288	0.205	0.218	0.168												
DFF	0.055	0.371	0.001	**0.595**	-0.027	-0.114												
DFB	-0.136	**0.713**	-0.067	0.081	0.008	0.408												
PH	**0.797**	0.261	-0.378	-0.114	0.059	0.009												
NBPP	**0.684**	0.117	-0.199	0.231	0.106	-0.041												
NSPP	**0.845**	0.174	-0.322	-0.135	0.057	-0.079												
NMPP	0.363	**0.529**	-0.106	-0.019	0.248	-0.335												
BW	**0.603**	-0.188	**0.561**	0.218	0.096	-0.208												
GP	-0.054	-0.207	-0.293	**0.519**	-0.219	**0.538**												
LI	0.683	-0.132	0.357	0.043	-0.19	0.41												
SI	0.7	-0.041	**0.488**	-0.292	-0.127	0.138												
2.5%SL	0.134	**0.592**	**0.508**	-0.206	-0.129	0.013												
UR	**0.446**	-0.271	-0.325	-0.204	**0.492**	0.093												
BS	-0.253	-0.131	0.473	0.005	**0.557**	0.353												
E%	0.147	-0.714	-0.331	-0.084	0.042	-0.065												
FF	0.403	-0.088	-0.126	0.151	-0.692	-0.025												
NSPB	0.132	-0.184	0.264	**0.772**	0.196	-0.376												
SCYPP	**0.493**	-0.133	0.005	0.229	0.249	0.4												

DOI: 10.5958/0975-928X.2017.00140.5

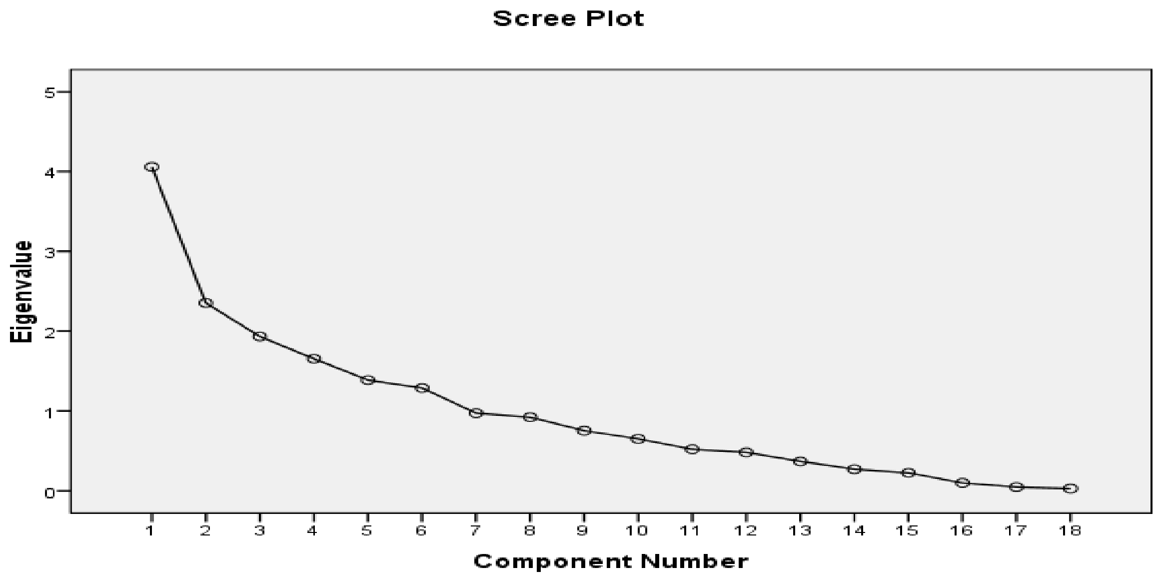

Fig. 1. Scatter diagram