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Principal component analysis for groundnut yield and seed attributes (*Arachis hypogaea* L.)

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Abstract
An intricate quantitative characteristic yield is highly dependent on its surroundings. Direct selection for grain production is a less effective way to boost groundnut production. The goal of the current study was to examine genotype for variability parameters in different lines. Phenotypic data was collected on thirteen quantitative characters for 56 genotypes under study carried out in randomised block design (RBD). Analysis has been done using GRAPES software program. Significant variations were found between the genotypes for every attribute in the analysis of variance, suggesting that there is a lot of genetic diversity among the genotypes. Plant height, the number of branches per plant, 100 kernel weight, kernel yield per plant are the most important characters which could be used as selection criteria for effective improvement of pod yield. Using GRAPES software, Thirteen Principal components are extracted based on mean values of which the first five PCs showed 86.24% variation with eigen values more than 1. Biplot constructed by Principal component analysis revealed Hundred pod weight and hundred kernel weight as important traits for study.

Keywords: Groundnut, Path coefficient analysis, Principal component analysis

Introduction
As the most significant oilseed crop of India, groundnut is referred to by several regional names, including Manila nut in the Philippines, Pindar nut in the United States, and Monkey nut in the United Kingdom. It has a high protein (25-30%) and oil (45-55%) content. It is grown across 29.92 million hectares worldwide, with an annual production of 55.30 million tons and 1851 kg/ha of productivity. With an area of 6.01 million hectares, 10.24 million tons of production, and 1703 kg/ha of productivity, India is the second-most productive country in the world for groundnut production (Ministry of Agriculture and Farmers Welfare, Govt of India 2020-21). It is grown on 0.87 Mha in Andhra Pradesh, where it produces 0.77 Mt and has an average yield of 891 kg/ha (AICRP-Annual Report 2020-2021). The selection of many characteristics involved in yield enhancement at the same time is made easier by the link between yield and its component elements. Yield has a multifaceted personality that is influenced by several interconnected traits.

Materials and Methods
The present study was carried out in randomized block design (RBD) with 56 groundnut varieties which falls in the series RVGN 1 to 108 to examine coordinate and indirect impacts by way examination and variety by principal Component analysis. The exploratory field work was carried out at Department of Plant Breeding and Genetics, Rajmata Vijyaraje Scindia Krishi Vishwa Vidyalaya, Gwalior in *kharif* season during the year 2021 and 2022 utilizing these 56 genotypes. Three plants were randomly chosen for each genotype from each replication. Observations on thirteen quantitative parameters *viz*., Days to 50% flowering, Days to maturity, Plant height (cm), Number of branches per plant, Number of pods per plant, Kernel number per plant, Kernel yield per plant (gm), 100 kernel weight (gm), Sound mature kernel (%), 100 pod weight (gm), Shell Outturn (%), Harvest index (%) and Pod yield per plant (gm) were recorded for all the genotypes. Mean of 3 plants were calculated and cruel values of three replications

were taken for measurable examination. Measurable examination of Principal component analysis was carried out utilizing GRAPES program.

Results and Discussion

Based on the data recorded in the current investigation, the analysis of variance revealed significant differences among all of the characters, indicating a substantial genetic diversity among the genotypes (Table 1). Principal component analysis (PCA) was conducted on the mean values of the groundnut genotypes using a correlation matrix. This analysis provided a reduced dimension model that could identify differences among the genotypes in the population (Table 1&2). The results highlighted the importance of the first five Principal Components (PCs) in distinguishing the groundnut population. Rotated component matrix revealed that first five PCs are representing maximum variability (86.5%) hence, the traits falling in these five PCs must be given due importance in breeding of groundnut. The scree plot graph (Fig 1) illustrates the variation explained by the various principal components.

First principal component recorded the highest variation 29.56% followed by 17.00% (second PC), 12.37% (third PC), 11.27% (fourth PC), and 8.31% (fifth PC). Total variation of five PCs was recorded as 78.44% Table (3&4). Semi curve line obtained after fifth PC with little variation observed in each PC indicated that maximum variation was found in first PC, therefore selection for characters under first PC may be desirable.

Table 1: Interpretation of rotated matrix for the traits having values >0.5 in each PCs in (Pooled)

PC1	PC2	PC3	PC4	PC5
KNPP	-	DM	DF	SO
100KW	-	NBP	PH	HI
100PW	-	NPP	-	-
-	-	KYPP	-	-
-	-	SMK	-	-

Among 56 genotypes, the top principal component scores (PC score) for all the traits were estimated in these five components and presented Table 4. These scores can be utilized to propose precise selection indices whose intensity can be decided by variability explained by each of principal component [6, 7]. High PC score for a particular genotype in a particular component denotes high values for the variables in that particular genotype (Fig. 1). Similar results were obtained by [1, 2-11].

Table 2: Eigen value and % variance of promising genotypes of groundnut (pooled)

Traits	PC	Pooled analysis	
		Eigen value	Variability (%)
DF	PC 1	118.549	37.8
DM	PC 2	56.996	18.2
PH	PC 3	43.285	13.8
NBP	PC 4	34.402	11
NPP	PC 5	17.992	5.7
KPP	PC 6	13.454	4.3
KYPP	PC 7	10.702	3.4
100KW	PC 8	8.549	2.7
SMK	PC 9	3.567	1.1
100PW	PC 10	2.894	0.9
SO	PC 11	2.394	0.8
HI	PC 12	0.434	0.1
PYPP	PC 13	0.004	0

Table 3: PC values of rotation component matrix for twelve variables of ninety genotypes of groundnut (pooled)

Traits	Principal components				
	PC 1	PC 2	PC 3	PC 4	PC 5
DF	0.007	-0.001	-0.027	0.106	0.182
DM	-0.017	0.543	0.637	-0.48	0.197
PH	0	0.275	0.362	0.838	0.127
NBP	0.001	-0.013	0.027	-0.005	-0.027
NPP	0.173	-0.389	0.348	-0.063	-0.055
KPP	0.378	-0.154	0.187	-0.053	-0.059
KYPP	0.078	-0.132	0.086	-0.012	0.003
100KW	0.218	0.01	0.129	0.187	-0.448
SMK	0.111	0.063	0.272	0.047	-0.285
100PW	0.9	0.283	-0.267	-0.032	0.137
SO	0.009	-0.063	0.042	0.064	0.092
HI	0.044	-0.267	0.059	0.074	0.771

Extraction method

Principal component analysis.

Values in bold represents more related traits in each principal component

Table 4: Superior genotypes among different PCs

S. No.	PCs	Superior genotypes among different PCs
1.	PC1	RVGN-36, RVGN-70, RVGN-54, RVGN-88, RVGN-43 , RVGN-90, RVGN-84, RVGN-4, RVGN-35, RVGN-45 and RVGN-103
2.	PC2	RVGN-78, RVGN-1, RVGN-45, RVGN-41, RVGN-90, RVGN-22, RVGN-110, RVGN-69 and RVGN-91
3.	PC3	RVGN-7, RVGN-91, RVGN-17, RVGN-22, RVGN-40, RVGN-79, RVGN-11, RVGN-78, RVGN-88, RVGN-114 and RVGN-19
4.	PC4	RVGN-4, RVGN-44, RVGN-9, RVGN-78, RVGN-42, RVGN-103, RVGN-70, RVGN-27, RVGN-49, RVGN-110 and RVGN-51
5.	PC5	RVGN-73, RVGN-79, RVGN-84, RVGN-70, RVGN-49, RVGN-83, RVGN-22 and RVGN-39

Rotated component matrix (Table 3 and 4) revealed that the PC1 which accounted for the highest variability (32.13%) was mostly related with traits such as number of pods per plant, kernel yield per plant, biological yield per plant and seed yield per plant [2,3,5&6]. In second PC the traits *viz.*, days to maturity was more related. The PC 3 was dominated by single trait *i.e.*, pod length (cm) and number of seeds per pod. The fourth component was more related to number of primary branches per plant and plant height whereas PC 5 was closely related to 100 seed weight and harvest index (%). On the basis of PCA most of the important yield and yield attributing traits were present in PC1 and PC2 (Fig 2).

Biplot analysis

An attempt has been made to observe the variation explained by thirteen quantitative characters along one and two principal component vectors i.e., Biplot (Fig 2). From Biplot, 13 characters were grouped into five groups. Kernel number per plant, 100 kernel weight, 100 pod weight were grouped in same cluster; Days to maturity, number of branches per plant, number of pods per plant, kernel yield per plant and sound mature kernel as single group [3, 4]. Those genotypes nearer to each trait can be said as best suited for those traits respectively. The genotypes RVGN-54 and RVGN-88 are best suited for kernel number per plant. Genotype RVGN-103 and RVGN-70 was highly suitable for plant height Table (3&4) (Fig. 2) [5]. Genotype RVGN-49 was highly suitable for shell outturn and contributed more to this trait. There is high correlation between hundred kernel weight and hundred pod weight. Similar results were observed by [7, 8, 10, 12].

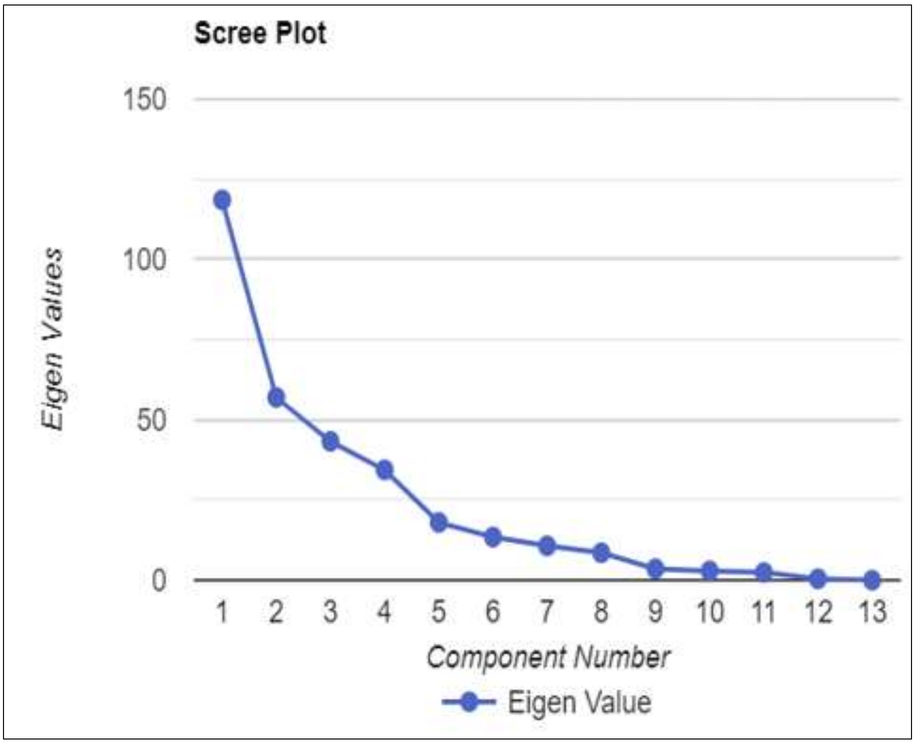

Fig 1: Scree plot

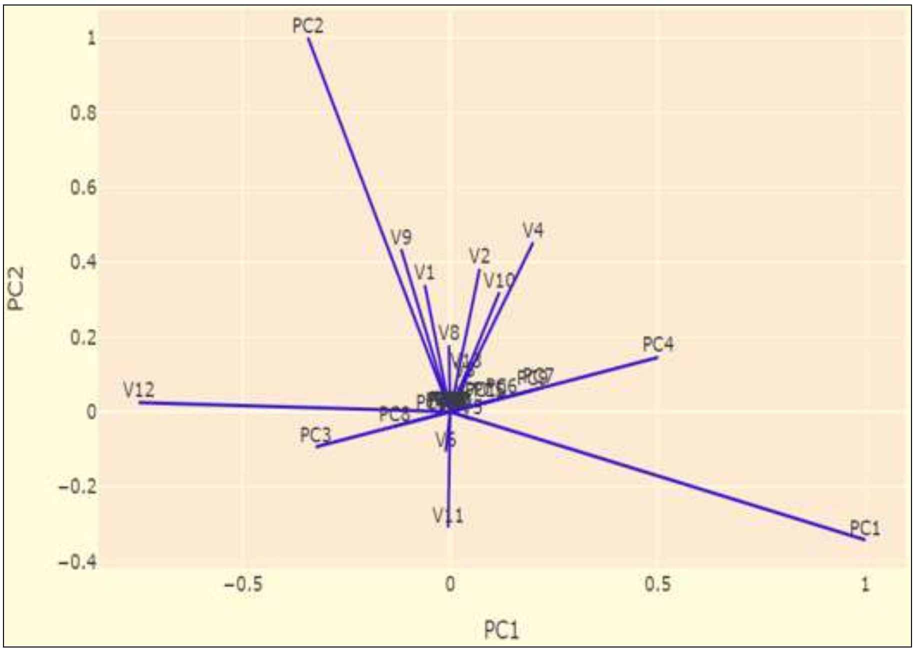

Fig 2: Biplot for different PC components

Conclusion

Among the yield component traits, significant positive correlations were observed between primary branches/trees, secondary branches/trees, 100-seed weight, and bark percentage. The Bi plot constructed using principal component analysis shows that the 100 kernel weight and sound mature kernel and pod yield per plant are important characteristics to study. Therefore, it is recommended to prioritize these traits in breeding programs to select superior lines with genetic potential for higher productivity in peanut genotypes.

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