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Nature and degree of distribution for yield and yield attributes in F_3 generations of groundnut (*Arachis hypogaea* L.)

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Abstract
Skewness and kurtosis statistics gives an insight into the shape of the distribution Considering the skewness dry pod yield per plant, kernel yield per plant and oil content recorded a negative skewness in all the four crosses indicating the role of non duplicate gene interactions and importance of mild selection to gain maximum genetic gain. Positively skewed distribution for traits days to physiological maturity, number of mature pods per plant, haulm yield per plant, HKW, shelling per cent, protein content and oleic acid content could be due to the favourable allelic interactions of both the parents involved and thus can be considered beneficial due to complimentary gene action in play. Intense selection for rapid genetic gain should be adopted here for improvement of these traits. Regarding kurtosis platykurtic nature was noticed in most of the traits under study. Thereby, directional selection will effectively improve the mean performance of these traits.

Keywords: Groundnut, population, skewness, kurtosis, yield, yield attributes

Introduction

Groundnut, also commonly known as peanut (*Arachis hypogaea* L.), is an important legume mainly grown to produce oil and for human and animal consumption. The peanut, grown in tropical and subtropical regions throughout the world is native to the Western Hemishpere. It is a self pollinating allotetraploid crop with basic chromosome number X=10 belonging to the family Leguminosae, subfamily Papillionoidae. It is commonly called as 'King' of oilseeds (Stalker *et al.,* 2016) [1].

An insight into the nature and degree of distribution present in population is of utmost importance as it forms the basis for selection in any crop improvement programme. Probably the most often used descriptive statistic is the mean and standard deviation. Sometimes even if these two measures are same for the distribution still the shape of the two curves may differ. One curve may be symmetric and the other may be asymmetric. An important perspective of the description of a variable is the shape of its distribution, which narrate the frequency of values from different ranges of the variable. Typically, a researcher is interested in how well the distribution can be approximated by the normal distribution. Higher order statistics can provide some information pertinent to this issue *i.e.,* skewness and kurtosis. The skewness and kurtosis statistical analysis provides the information about nature of gene action (Fisher *et al.,* 1932) [2]. and number of genes controlling the trait (Robson, 1956) [3]. Generally, skewed distribution of the characters implies the control of non additive type of gene effects and influenced by environmental variables. Positive skewness explained the complementary gene action whereas, negative skewness related to duplicate (additive × additive) gene effects (Kiran, 2012) [4]. Kurtosis characterizes the degree of peakedness of a distribution relative to normal distribution. Positive kurtosis of the characters indicates the presence of gene interactions while for negative sign of kurtosis or near to zero leads the absence of gene interactions (Kotch *et al.,* 1992) [5]. Also, positive kurtosis indicates leptokurtic distribution, caused by fewer numbers of genes while negative kurtosis indicates platykurtic distribution, caused by large number of genes controlling quantitative traits.

Material and method

Study area

The present scientific investigation on groundnut was carried out during *kharif* 2018 at Main Agriculture Research Station, College of agriculture, University of Agricultural Sciences, Raichur, which is situated in the North-Eastern dry zone of Karnataka (Zone 2). The experimental soil was of sandy clay loam type.

Experimental material

The experimental material consisted of four released/advanced breeding parents *viz.,* Kadri-9, GPBD-4, ICGV-00351 and Sunoleic-95R. Four F_3 populations derived from the crosses of above mentioned parents' *viz.*, Kadri-9 x GPBD-4, ICGV-00351 x GPBD-4, Kadri-9 x Sunoleic-95R and ICGV-00351 x Sunoleic-95R were utilised for the present study where, GPBD-4 and Sunoleic-95R were the common male parent. All the parents and F_3 progenies were evaluated in non-replicated trial. Recommended cultural practices were followed throughout the crop growing period. The spacing put into practice was 30 × 10 cm.

Observations recorded

In the present investigation observations were recorded and analysed for eleven traits *viz.,* days to physiological maturity, plant height (cm), number of mature pods per plant, dry pod yield per plant (g), kernel yield per plant (g), haulm yield per plant (g), shelling (per cent), hundred kernel weight (g), oil content (per cent), protein content (per cent) and oleic acid content (per cent) in different crosses to draw conclusions about the distribution of characters and to understand the nature of genetic control of target traits. The skewness and kurtosis were calculated by adopting the statistical procedures given by Karl person. According to him, β_2 = skewness and if $\beta_2 > 0$, then positively skewed; $\beta_2 < 0$, then negatively skewed. Similarly, γ_2 = kurtosis and if $\gamma_2 > 0$, then leptokurtic; $\gamma_2 < 0$, then platykurtic.

Result and discussion

To study the distribution Skewness and Kurtosis provides information about the nature of gene number of genes controlling the traits respectively. Any trait exhibiting positive Skewness is governed by complimentary gene action and rigorous selection has to be carried out for such traits to achieve the genetic gain in rapid time. Whereas if the trait is governed by duplicate gene action *i.e.,* negatively skewed), mild selection can be followed to attain rapid genetic gain of such trait (Snape and Riggs 1975) [6]. Four crosses *viz.,* Kadri-9 x GPBD-4, ICGV-00351 x GPBD-4, Kadri-9 x Sunoleic-95R and ICGV-00351 x Sunoleic-95R in F_3 generation were studied for the nature and degree of population distribution for yield and yield attributing traits using the measures of shape. The results on the estimates of skewness, kurtosis and their distribution across the segregating populations for yield and yield attributes are presented in tables 1 and discussed hereunder.

Cross 1-Kadri-9 x GPBD-4

A positively skewed platykurtic distribution was observed for the traits like days to physiological maturity (1.048, -0.110), number of mature pods per plant (0.377, -0.501), shelling percent (0.378, -0.477) and oleic acid content (0.460, -0.193) in the populations of above cross suggesting that the expression of the traits are controlled by large number of genes with complementary epistasis. The positively skewed distribution also suggested that the genetic gain could be rapid with mild selection and less rapid with vigorous selection for target traits. The curves are asymmetric, and skewed to the right for the above traits which can be depicted from the histogram and consistent with the fact that the skewness is positive.

Further negative skewness with platykurtic distribution was also observed for certain traits like plant height (-0.522, -0.149), dry pod yield per plant (-0.204, -1.130), kernel yield per plant (-0.116, -1.034) and protein content (-0.047, -0.409) thus suggesting the involvement of large number of genes with majority of them displaying duplicate epistasis and mild selection would be sufficient to get rapid genetic gain. Leptokurtic distribution with negative skewness was observed only for the trait oil content (-1.459, 3.222) in the above cross indicating the role of fewer numbers of genes with majority of them exerting decreasing effects on the expression of the trait. Positively skewed leptokurtic distribution was observed for the trait haulm yield per plant (0.980, 1.287) and hundred kernel weight (0.931, 2.158) which requires strict selection for increasing the genetic gain of these traits.

Cross 2- ICGV-00351 x GPBD-4

The frequency distribution studies in the population of the above cross depicted a positively skewed platykurtic distribution suggesting the involvement of large number of genes with majority of them displaying complementary epistasis with increasing effects on the expression of protein content per plant (0.160, -0.410) while a negatively skewed platykurtic distribution was observed for kernel yield per plant (-0.522, -0.614), dry pod yield per plant (-0.576, -0.606), and plant height (-0.278, -0.700). Similarly positively skewed leptokurtic distribution indicated the role of fewer numbers of genes with majority of them exerting decreasing effects on the expression of days to physiological maturity (2.025, 4.605), number of mature pods per plant (0.941, 4.589), haulm yield per plant (1.021, 1.245), shelling per cent (2.514, 3.327), hundred kernel weight (2.579, 3.943) and oleic acid content (2.518, 7.463). Leptokurtic and a negative skewness was observed for oil content (-1.519, 3.877) trait which tends to be associated with duplicate (additive × additive) gene interactions. Hence we can go for strict selection and mild selection for positively and negatively skewed traits respectively in order to get rapid genetic gain in these traits.

Cross 3- Kadri-9 x Sunoleic-95R

For the population of above cross number of mature pods per plant (0.240, -0.825) exhibited a positive skewness with platykurtic distribution indicating the role of large number of genes which has dominant based complimentary type gene action. Expected genetic gain would be rapid with intense selection for the improvement of this trait. Skewness was negative for kernel yield per plant (-0.074, -1.180), dry pod yield per plant (-0.113, -1.201) and protein content (-0.269, -0.075) with platykurtic distribution and thus governed by a large number of genes having duplicate type gene interaction. Mild selection would be sufficient for rapid genetic gain of these traits.

Positively skewed leptokurtic distribution indicated the role of fewer numbers of genes with majority of them exerting decreasing effects on the expression of days to physiological maturity (2.213, 2.898), haulm yield per plant (1.068, 1.843), shelling percent (1.250, 3.200), hundred kernel weight (1.485, 3.724) and oleic acid content (0.103, 0.300) which requires strict selection for increasing genetic gain. Negatively skewed leptokurtic distribution was observed for the traits plant height (-0.993, 1.709) and oil content (-1.265, 1.294) which indicates traits are governed by few genes with duplicate gene interaction.

Cross 4-ICGV-00351 x Sunoleic-95R

In the present study of this cross positively skewed distribution was observed for traits like days to physiological maturity (1.248), plant height (0.310), number of mature pods per plant (0.328), hundred kernel weight (1.463), haulm yield per plant (1.517), protein content (0.312) and oleic acid content (0.477) which can be improved through strict selection. From the above mentioned traits, days to physiological maturity (2.665), plant height (0.077), number of mature pod per plant (0.459), protein content per plant (0.524), hundred kernel weight per plant (6.164) and haulm yield per plant (4.129) showed a leptokurtic distribution whereas trait oleic acid content per plant (-1.433) showed a platykurtic frequency distribution. Similarly negatively skewed platykurtic distribution suggesting the involvement of large number of genes with majority of them displaying duplicate (additive x additive) gene interactions that can be improved by mild selection are observed for traits kernel yield per plant (-0.713, -0.293), dry pod yield per plant (-0.749, -0.290) and shelling per cent (-0.044, -1.234). Oil content trait showed a duplicate gene action governed by few genes due to its negatively skewed leptokurtic nature (-1.033, 1.689) that can be improved by mild selection.

Conclusion

Negative skewed platykurtic distribution was observed for traits dry pod yield per plant, kernel yield per plant and oil content (per cent) in all the crosses. Hence it is known that these traits are governed by large number of gene having duplicate type of epistasis and hence mild selection would be sufficient to get rapid genetic gain for these traits. In the present study positive skewness with leptokurtic distribution was observed in most of crosses for the traits days to physiological maturity, haulm yield, HKW and oleic acid content which thus demands strict selection for increased genetic gain. Prabhu *et al.* (2015c) [7] observed leptokurtosis for days to physiological maturity, number of mature pods per plant, shelling (per cent), HKW (g) and oleic acid content (per cent). This factor was also evident from the findings of Ajay *et al.* (2016) [8]. Platykurtosis for oil content was evident in the studies of Divyadarshini *et al.* (2017) [9]. Thereby, directional selection will effectively improve the mean performance of these traits.

Table 1: Estimates of skewness and kurtosis for quantitative and qualitative traits in F_3 populations derived from four crosses in groundnut**.**

Sl. No.	Characters	Cross	Skewness	Kurtosis
1	Days to physiological maturity	Kadri-9 x GPBD-4	1.048	-0.110
		ICGV-00351 x GPBD-4	2.025	4.605
		Kadri-9 x Sunoleic-95R	2.213	2.898
		ICGV-00351 x Sunoleic 95R	1.248	2.665
2	Plant height (cm)	Kadri-9 x GPBD-4	-0.522	-0.149
		ICGV-00351 x GPBD-4	-0.278	-0.700
		Kadri-9 x Sunoleic-95R	-0.993	1.709
		ICGV-00351 x Sunoleic 95R	0.310	0.077
3	Number of mature pods/plant	Kadri-9 x GPBD-4	0.377	-0.501
		ICGV-00351 x GPBD-4	0.941	4.589
		Kadri-9 x Sunoleic-95R	0.240	-0.825
		ICGV-00351 x Sunoleic 95R	0.328	0.459
4	Dry pod yield (g/plant)	Kadri-9 x GPBD-4	-0.204	-1.130
		ICGV-00351 x GPBD-4	-0.576	-0.606
		Kadri-9 x Sunoleic-95R	-0.113	-1.201
		ICGV-00351 x Sunoleic 95R	-0.749	-0.290
5	Kernel yield (g/plant)	Kadri-9 x GPBD-4	-0.116	-1.034
		ICGV-00351 x GPBD-4	-0.522	-0.614
		Kadri-9 x Sunoleic-95R	-0.074	-1.180
		ICGV-00351 x Sunoleic 95R	-0.713	-0.293
6	Haulm yield (g/plant)	Kadri-9 x GPBD-4	0.980	1.287
		ICGV-00351 x GPBD-4	1.021	1.245
		Kadri-9 x Sunoleic-95R	1.068	1.843
		ICGV-00351 x Sunoleic 95R	1.517	4.129
7	Shelling (%)	Kadri-9 x GPBD-4	0.378	-0.477
		ICGV-00351 x GPBD-4	2.514	3.327
		Kadri-9 x Sunoleic-95R	1.250	3.200
		ICGV-00351 x Sunoleic 95R	-0.044	-1.234
8	Hundred kernel weight (g)	Kadri-9 x GPBD-4	0.931	2.158
		ICGV-00351 x GPBD-4	2.579	3.943
		Kadri-9 x Sunoleic-95R	1.485	3.724
		ICGV-00351 x Sunoleic 95R	1.463	6.164
9	Oil content (%)	Kadri-9 x GPBD-4	-1.459	3.222
		ICGV-00351 x GPBD-4	-1.519	3.877
		Kadri-9 x Sunoleic-95R	-1.265	1.294
		ICGV-00351 x Sunoleic 95R	-1.033	1.689
10	Protein content (%)	Kadri-9 x GPBD-4	-0.047	-0.409
		ICGV-00351 x GPBD-4	0.160	-0.410
		Kadri-9 x Sunoleic-95R	-0.269	-0.075
		ICGV-00351 x Sunoleic 95R	0.312	0.524
11	Oleic acid content (%)	Kadri-9 x GPBD-4	0.460	-0.193
		ICGV-00351 x GPBD-4	2.518	7.463
		Kadri-9 x Sunoleic-95R	0.103	0.300
		ICGV-00351 x Sunoleic 95R	0.477	-1.433

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