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Assessment of genetic parameters for yield, yield component and quality traits in groundnut germplasm. (*Arachis hypogaea* L.)

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Abstract
Twenty seven groundnut genotypes were grown in randomized block design with three replications and evaluated for sixteen yield attributing, physiological and quality characters. Highly significant differences and adequate variability were obtained among the genotypes for all the selected characters. Analysis of variance revealed the existence of significant differences among genotypes for all characters studied A wide range of variation was observed for all the important yield attributing, physiological and quality characters *viz*., days to 50% flowering, days to maturity, SPAD chlorophyll meter reading at 60 DAS, specific leaf area at 60 DAS, plant height, number of primary branches plant^{-1}, number of mature pods plant^{-1}, hundred pod weight, hundred kernel weight, harvest index, shelling per cent, kernel yield plant^{-1}, dry haulms yield plant^{-1}, pod yield plant^{-1}, oil content and protein content indicating substantial genetic variability existing among the genotypes. Groundnut genotypes with high protein content (14) and oil content (7) were identified citing the possibility to develop high yielding lines with high quality traits with superior nutritional features. The parameters have indicated sufficient variability for different nutritional characters, so that it would enable the breeder to utilize appropriate genetic resources in the crossing programme to improve the particular character. Hence, this investigation provides ample scope for appropriate trait selection and genetic improvement in groundnut breeding programme.

Keywords: Variability, mean performance, box plots, groundnut (*Arachis hypogaea* L.)

Introduction
Groundnut is also known as the "King of Oilseeds" because it contains a high proportion of polyunsaturated fatty acids (PUFA) (40-50%) and monounsaturated fatty acids (MUFA) (Mohamed Abbas *et al*., 2020). Essential fatty acids such as linoleic acid (25–35%), makes groundnut oil both nutritionally rich and oxidation-stable. The presence of natural antioxidants, particularly tocopherols (about 0.9 mg/g oil) prevent rancidity and extend shelf life. Groundnut oil is cholesterol-free, rich in antioxidants and vitamin E, making it heart-friendly and beneficial for overall health. Globally, groundnut is cultivated an area of 30.19 million hectares, with a production of 51.2 million metric tonnes with an average productivity of 1,700 kg ha^{-1} (United states department of agriculture, 2026). India contributes significantly to global groundnut production, with 5.87 million hectares under cultivation, yielding 13.07 million tonnes at a productivity of 2,228 kg ha^{-1}. The country ranks first in the world in terms of area cultivated area and second in production after China. In Andhra Pradesh, groundnut occupies 0.29 million hectares and producing 0.430 million tonnes with a productivity of 1,476 kg ha^{-1} during 2025-26 (Ministry of Agriculture, 2025-26). Pod yield in groundnut is a complex quantitative trait controlled by several physiological and morphological characters and strongly influenced by environmental factors. Successful crop improvement depends on the availability and effective utilization of genetic variability present in the breeding material which provides the basis for selecting superior genotypes with improved yield and desirable traits.

Materials and methods
Twenty seven genotypes of groundnut were sown in a Randomized Block Design (RBD) with three replications at S.V.Agricultural College, Tirupati, ANGRAU during the kharif season of 2025. Each genotype was accommodated in a single row of 3.0 m length with a spacing of 30 cm between rows and 10 cm between plants within the row.
The experiment was surrounded by two guard rows to avoid damage and border effects. All recommended agronomical practices in vogue were followed for reaping good crop. Data were recorded on fifteen characters *viz*., days to 50% flowering, days to maturity, plant height (cm), number of primary branches per plant, SPAD chlorophyll meter reading, Specific leaf area number of mature pods per plant, pod yield per plant (g), 100-pod weight (g), kernel yield per plant (g), 100-kernel weight (g), shelling percent , dry haulms yield per plant (g), shelling out-turn (%), harvest index (%) and oil content (%) and protein content (%). Except, days to 50% flowering and days to maturity where, data recorded on plot basis, data on rest of the morphological traits were recorded on randomly selected five competitive plants from each accession and average value was used for the statistical analysis. The data subjected to different statistical analysis *viz*., analysis of variance and magnitude of genetic variability were performed following the standard procedures. (Table 1)

Results and Discussion
Data recorded for sixteen characters were subjected to analysis of variance and the results are presented in Table 1. The analysis of variance revealed highly significant differences were observed among the genotypes for all the characters *viz.*, days to 50% flowering, days to maturity, SPAD chlorophyll meter reading at 60 DAS, specific leaf area at 60 DAS, plant height, number of primary branches

plant^{-1}, number of mature pods plant^{-1}, hundred pod weight, hundred kernel weight, harvest index, shelling per cent, kernel yield plant^{-1}, dry haulms yield plant^{-1}, pod yield plant^{-1}, oil content and protein content. These significant differences indicate the existence of substantial genetic variability among the genotypes providing ample scope for effective selection and genetic improvement in groundnut breeding programme. Box plot (Fig.1) further confirmed substantial variation among genotypes across all studied characters emphasizing the availability of exploitable genetic diversity. (Table 3)

This variability realizes the potential scope for genetic improvement of key variables and their interaction with environment factors gives opportunity for effective selection in subsequent breeding programs in groundnut. (Attia *et al.*, 2020 & Kanappa *et al.*, 2022) [2]. The *perse* means of all characters studied are presented below (Table 2)

Table 1: Analysis of variance for physiological, yield attributes and quality traits in groundnut

S.no	Characters	Mean sum of squares		
		Replication (df:2)	Genotypes (df:26)	Error (df:52)
1	Days to 50% flowering	2.259	3.641**	0.90
2	Days to maturity	5.086	9.596**	2.176
3	SPAD chlorophyll meter reading at 60 DAS	17.900	33.826**	6.362
4	Specific leaf area at 60 DAS (cm^2g^{-1})	33.407	2360.99**	235.634
5	Plant height(cm)	5.463	141.905**	5.415
6	Number of primary branches plant^{-1}	0.319	5.241**	0.256
7	Number of mature pods plant^{-1}	2.100	17.261**	1.515
8	Hundred pod weight (g)	2.285	328.595**	8.044
9	Hundred kernel weight (g)	11.353	35.971**	3.755
10	Shelling per cent	3.890	56.471**	1.752
11	Dry haulms yield plant^{-1} (g)	1.851	38.665**	2.479
12	Harvest index (%)	10.663	77.351**	3.918
13	Kernel yield plant^{-1}(g)	1.945	25.710**	1.125
14	Oil content %	0.854	6.155**	0.961
15	Protein content%	1.099	35.716**	1.986
16	Pod yield plant^{-1} (g)	4.167	46.760**	1.493

Table 2: Per se performance of groundnut genotypes for physiological, yield attributes and quality traits

Genotypes	DFF	DM	SCMR	SLA	PH	NPB	NMP	HPW	HKW	SP	DHY	HI	KYP	OC	PC	PYP
TCGS-2578	28.00	103.00	36.93	136.00	45.01	9.03	15.73	94.10	42.16	60.22	27.25	38.37	9.5	49.08	17.73	16.96
TCGS-2580	29.33	102.00	37.63	164.21	34.13	5.79	11.73	87.59	45.00	60.95	22.72	31.73	6.4	48.21	26.11	10.56
TCGS-2581	29.67	102.67	36.80	168.57	39.25	5.87	16.53	93.04	42.08	65.20	24.36	36.50	9.4	49.01	20.25	14.00
TCGS-2583	27.33	102.33	43.03	100.26	30.17	6.63	16.00	90.25	40.09	65.90	19.27	39.04	8.6	48.86	22.56	12.34
TCGS-2584	28.33	103.33	39.70	121.46	31.40	5.73	12.60	89.72	42.33	61.88	21.89	38.68	10.7	48.93	24.64	13.81
TCGS-2585	29.33	102.00	37.13	153.10	41.01	9.12	15.73	92.92	41.49	70.59	25.19	40.66	9.74	49.46	16.38	17.26
TCGS-2586	30.33	99.00	36.03	134.50	41.28	5.27	12.40	94.05	46.00	63.65	25.29	32.09	7.58	48.59	20.83	11.95
TCGS-2631	29.33	105.33	41.37	110.46	34.33	8.13	20.27	86.83	42.66	71.70	23.80	38.99	10.9	50.14	18.60	15.21
TCGS-2635	27.67	98.00	40.70	187.94	48.41	5.20	15.33	104.01	46.14	63.11	29.58	43.01	14.1	49.12	21.81	22.32
TCGS-2636	29.00	100.67	38.47	171.75	45.59	4.40	13.40	100.10	46.00	67.50	27.68	40.00	12.6	48.60	23.51	18.45
TCGS-2642	29.33	104.33	39.50	109.14	37.68	5.33	15.60	83.88	39.50	69.27	24.31	29.39	7.0	48.42	25.83	10.12
TCGS-2643	28.67	103.67	42.83	168.64	48.20	4.91	15.07	98.79	45.21	66.16	28.43	43.63	14.6	46.12	27.41	22.00
TCGS-2644	29.33	101.00	36.57	160.22	43.69	5.67	11.53	100.38	42.00	65.32	25.69	31.84	7.9	48.02	24.03	12.00
TCGS-2645	27.67	99.67	36.23	167.35	46.25	7.45	16.00	89.44	40.00	62.07	27.79	43.33	13.2	47.12	29.71	21.25
TCGS-2647	30.67	103.67	44.23	168.08	44.34	6.13	12.00	113.14	44.66	63.48	26.20	31.38	7.6	44.19	29.09	11.98
TCGS-2648	28.67	103.67	46.07	210.00	43.58	6.61	13.27	121.69	55.74	72.94	25.63	47.90	17.1	47.06	28.54	23.56
TCGS-2649	29.67	102.33	43.90	144.77	31.36	5.15	14.00	112.35	48.00	64.01	20.99	40.19	9.0	45.79	27.33	14.10
TCGS-2650	30.67	98.67	34.53	170.64	52.86	4.07	14.00	93.66	43.15	62.12	33.09	29.13	8.4	48.04	23.17	13.60
TCGS-2651	30.00	101.67	41.10	127.31	27.54	4.40	11.93	116.25	49.00	69.20	18.87	41.92	9.2	46.12	28.54	13.62
TCGS-2652	29.00	103.33	41.37	133.62	35.33	7.68	11.60	103.19	41.17	62.15	23.92	35.65	8.23	48.06	22.80	13.25
TCGS-2654	30.00	100.67	33.97	167.93	51.02	4.27	14.93	90.75	42.15	63.19	32.20	33.88	10.43	47.56	26.98	16.50
TCGS-2656	29.33	99.67	38.00	147.06	41.86	5.00	14.87	97.46	44.00	62.67	25.44	37.43	9.50	47.90	25.12	15.22
TCGS-2657	26.00	99.00	36.07	154.21	51.23	5.60	16.00	95.49	48.09	62.77	32.71	39.19	13.13	48.12	26.22	21.08
TCGS-2658	29.00	101.67	42.63	158.56	44.75	4.60	9.80	121.36	45.53	68.50	26.81	36.18	10.40	48.56	24.73	15.20
TCGS-2660	28.67	103.33	34.70	168.46	47.27	6.93	19.60	88.53	45.00	75.30	28.09	41.78	15.18	46.53	25.86	20.16
visishta (C)	29.67	102.67	43.47	105.89	37.14	4.73	14.20	100.54	47.79	73.79	24.11	47.78	15.92	48.60	25.80	22.06
K6 (C)	27.67	102.33	38.30	201.26	39.49	5.14	12.93	97.45	43.00	70.01	24.40	40.28	11.53	47.91	24.75	16.46
Mean	29.00	102.20	39.31	152.25	41.25	6.13	14.33	98.53	44.37	66.12	25.77	38.15	10.66	47.90	24.38	16.08
Minimum	26.00	98.00	33.97	100.26	27.54	4.07	9.80	83.88	39.50	60.22	18.87	29.13	6.43	44.19	16.38	10.12
Maximum	30.67	105.33	46.07	210.00	52.86	9.12	20.27	121.69	55.74	75.30	33.09	47.90	17.14	50.14	29.71	23.56
C.V	3.27	1.44	6.42	10.08	5.64	8.26	8.59	2.88	4.37	4.15	6.11	5.19	6.95	2.05	5.78	7.60
C.D.5%	1.55	2.42	4.13	25.15	3.81	0.83	2.02	4.65	3.17	4.50	2.58	3.24	1.21	1.61	2.31	2.00

DFF : Days to 50% flowering, DM : Days to maturity, SCMR : SPAD chlorophyll meter reading at 60 DAS, SLA : Specific leaf area at 60 DAS (cm^2 g^{-1}), PH : Plant Height (cm), NPB : No of primary branches plant^{-1} (g), NMP : No of mature pods plant^{-1} HPW : Hundred pod weight (g), HKW : Hundred kernel weight (g)

SP : Shelling percent, HI : Harvest index (%), DHY : Dry haulms yield plant^{-1} , KYP : Kernel yield plant^{-1} (g), OC : Oil content (%), PC : Protein content, PYP : Pod yield plant^{-1} (g)

Table 3: Variability parameters studied using Box plot analysis

Trait	Mean	Median	IQR Range	Skewness	Outlier	Variability
Days to 50% flowering	28.98	29.33	28.33–29.67	Negative	Yes (26.00)	Low
Days to maturity	101.84	102.33	100.67–103.33	Symmetric	No	Low
SLA at 60 DAS	152.27	158.56	133.62–168.57	Positive	No	High
Plant height (cm)	41.27	41.86	35.33–46.25	Slight negative	No	Moderate
Primary branches plant^{-1}	5.88	5.60	4.91–6.63	Positive	No	Moderate
Mature pods plant^{-1}	14.34	14.20	12.40–15.73	Symmetric	No	Moderate
100 pod weight (g)	98.41	95.49	90.25–103.19	Positive	No	Moderate–High
100 kernel weight (g)	44.37	44.00	42.08–46.00	Positive	Yes (55.74)	Low
Shelling percent (%)	66.06	65.30	62.67–69.27	Positive	No	Low–Moderate
Dry haulms yield plant^{-1}	25.77	25.44	23.92–27.79	Symmetric	No	Moderate
Harvest index (%)	38.15	38.99	33.88–41.78	Negative	No	High
Kernel yield plant^{-1} (g)	10.66	9.74	8.43–13.13	Positive	No	High
Oil content (%)	47.93	48.12	47.12–48.86	Slight negative	Yes (44.19)	Low

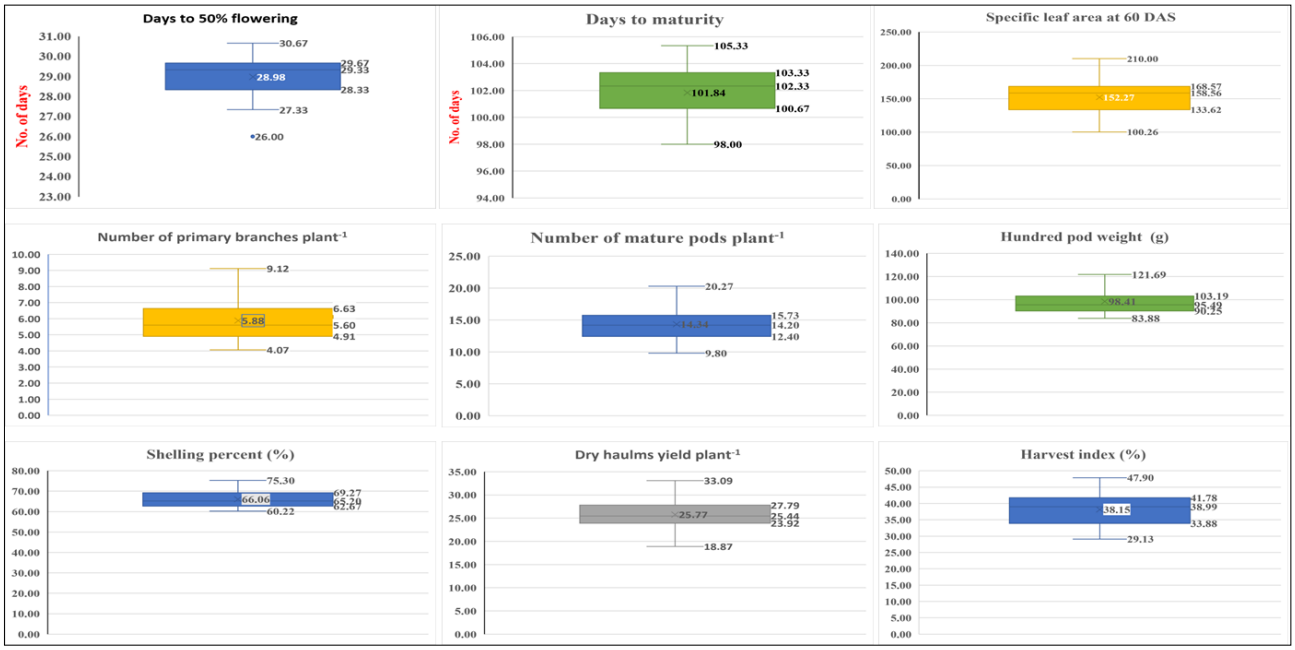

Fig 1: Box plot showing variability for yield attributing , physiological & quality traits in Groundnut.

1. Days to 50% Flowering

The *per se* performance for days to 50% flowering ranged from 26.00 days (TCGS-2657) to 30.67 days (TCGS-2647) with a mean of 29 days. Ten genotypes were found early in flowering than general mean 29 days. Six genotypes had showed significantly early flowering than best check Visishta (29.67) and TCGS-2657 genotype had showed significantly early in flowering than better check K-6 (27.67). Therefore, these genotypes can be utilized in the hybridization programme as donor parents to evolve short duration genotypes.

2. Days to Maturity

Days to maturity varied from 98.00 days (TCGS-2635) to 105.33 days (TCGS-2631) with general mean of 102.20 days. Thirteen genotypes came to maturity earlier than general mean of 102.20 days. Six genotypes had showed early in maturity than check variety Visishta (102.67) and K-6 (102.33).Therefore, these genotypes can be utilized in the hybridization programme as donor parents to evolve early maturing genotypes (Fig.4.2).

3. SPAD Chlorophyll Meter Reading at 60 DAS (SCMR)

Means of SPAD chlorophyll meter reading at 60 DAS ranged from 33.97 (TCGS-2654) to 46.07 (TCGS-2648) with general mean of 39.31. Thirteen genotypes recorded higher SPAD chlorophyll meter reading at 60 DAS than their general mean 39.31. TCGS-2647, TCGS-2648 and TCGS-2649 genotypes recorded significantly higher SPAD chlorophyll meter reading at 60 DAS than check K-6 (38.30).

4. Specific Leaf Area (Sla) At 60 Das (Cm^2 G^{-1})

Mean values for specific leaf area at 60 DAS among genotypes ranged from 100.26 cm^2 g^{-1} (TCGS-2583) to 210.00 cm^{2}g^{-1} (TCGS-2648) with a mean value of 152.25 cm^2 g.$^{-1}$ Eleven genotypes registered lower specific leaf area at 60 DAS than their general mean 152.25 cm^2 g^{-1}. Twenty seven genotypes recorded lower than the best check K-6

(201.26) and six genotypes showed significance than check Visishta (105.89).

5. Plant Height (cm)

Plant height mean values ranged from 27.54 cm (TCGS-2651) to 52.86 cm (TCGS-2650) among the genotypes with the general mean of 41.25 cm. Twelve genotypes recorded lower plant height than general mean 41.25(cm). Fourteen genotypes recorded significantly lower plant height than the best check K-6 (39.49cm) and Eleven genotypes recorded significantly lower plant height for the better check Visishta (37.14cm.)

6. Number of primary Branches Plant^{-1}

Number of primary branches plant^{-1} ranged from 4.07 (TCGS-2650) to 9.12 (TCGS-2585). Eight genotypes recorded more number of primary branches plant^{-1} than general mean of 6.13. Fourteen genotypes recorded more number of primary branches plant^{-1} than best check Visishta (4.73) and nine genotypes recorded more number of primary branches plant^{-1} than better check K-6 (5.14)

7. Number of Mature Pods Plant^{-1}

Number of mature pods plant^{-1} ranged from 9.80 (TCGS-2658) to 20.27 (TCGS-2631) with a general mean of 14.33. Thirteen genotypes recorded more number of mature pods plant^{-1} than general mean of 14.33. TCGS-2581, TCGS-2660 and TCGS-2631 genotypes recorded more number of mature pods plant^{-1} than best check Visishta (14.20) and eleven genotypes recorded more number of mature pods.

8. Hundred Pod Weight (g)

For hundred pod weight, mean values varied from 83.88 g (TCGS -2642) to 121.69 g (TGCS-2648). Eleven genotypes registered higher hundred pod weight than general mean of 98.53g. Five genotypes registered higher hundred pod weight than best check Visishta (100.54 g) and seven genotypes registered higher hundred pod weight than better check K-6 (97.45 g).

9. Hundred Kernel Weight (g)

For hundred kernel weight, mean values varied from 39.50 g (TCGS-2642) to 55.74 g (TGCS-2648). Thirteen genotypes registered higher hundred kernel weight than general mean of 44.37 g. TCGS-2648 genotype registered higher hundred kernel weight than check Visishta (47.79g) and five genotypes registered higher hundred kernel weight than check K-6 (43.00g) .

10. Shelling Per cent

Mean values for shelling per cent ranged from 60.27% (TCGS-2578) to 73.44% (TCGS-2648). Eleven genotypes recorded higher shelling percent than general mean of 66.12%. TCGS-2660 genotype recorded higher shelling percent than check K-6 (70.01%). None of the genotypes recorded significantly higher shelling percent than the check Visishta (73.79%).

11. Dry Haulms Yield Plant^{-1} (g)

Mean values for dry haulms yield plant^{-1} ranged from 18.87 g (TCGS 2651) to 33.09 g (TCGS-2650). Out of 27 genotypes, eleven of them recorded higher value than general mean of 25.77g. Ten genotypes recorded high dry haulms yield plant^{-1} than best check Visishta (24.11g) and nine genotypes recorded high dry haulms yield plant^{-1} than better check K-6 (24.40 g).

12. Harvest Index (%)

Mean of genotypes ranged from 29.13% (TCGS-2650) to 47.90% (TCGS-2648). Sixteen genotypes registered higher harvest index than general mean of 38.15%. Three genotypes registered higher harvest index than check K-6 (40.28%) None of the genotypes recorded significantly higher harvest index than the check Visishta.

13. Kernel Yield Plant^{-1} (g)

Mean values of genotypes for kernel yield plant^{-1} varied from 7.12 g (TCGS-2642) to 17.26 g (TCGS-2648). Eleven genotypes recorded higher kernel yield plant^{-1} than general mean of 10.66 g. TCGS-2648 genotype recorded higher kernel yield plant^{-1} than check Visishta (15.92g) and seven genotypes recorded higher kernel yield plant^{-1} than check K-6 (11.53g).

14. Oil Content (%)

Mean values for oil content in seeds ranged from 44.19% (TCGS-2647) to 50.14 % (TCGS-2631). Eighteen genotypes recorded higher oil content than general mean of 47.90%. TCGS-2631 genotype recorded higher oil content than check K-6 (47.91%). None of the genotypes recorded significantly higher oil content than the check Visishta (48.60%).

15. Protein Content (%)

Protein content ranged from 16.38% (TCGS-2585) to 29.09 % (TCGS-2647). Sixteen genotypes recorded higher protein content than general mean of 24.38%. Six genotypes recorded higher protein content than best check K-6 (24.75%). Four genotypes recorded higher protein content than better check Visishta (25.80%).

16. Pod yield plant^{-1} (g)

Mean values of genotypes for pod yield plant^{-1} varied from 10.12 g (TCGS-2642) to 23.56 g (TCGS-2648). Twelve genotypes recorded higher pod yield per plant than general mean of 16.08 g. Eight genotypes recorded higher pod yield per plant than check K-6 (16.46 g).

Based on *per se* performance superior genotypes for each character identified may be exploited in breeding programmes for the improvement of desirable physiological, yield and quality traits. (Table 4) Among the evaluated genotypes, TCGS-2648, TCGS-2635, TCGS-2645, TCGS-2657 and TCGS-2650 exhibited superior performance for most of the characters. The genotype, TCGS-2648 showed better performance for SPAD chlorophyll meter reading at 60 DAS, 100-pod weight, 100-kernel weight, pod yield plant^{-1} , kernel yield plant^{-1} **,** shelling percent, harvest index, protein content. The genotype, TCGS-2635 recorded higher values for days to 50% flowering, days to maturity, pod yield plant^{-1} ,kernel yield plant^{-1} , dry haulms yield plant^{-1} **,** harvest index, oil content. The genotype, TCGS-2645 came to maturity early with early flowering and showed higher values for pod yield plant^{-1}, number of primary branches per plant , harvest index, and protein content. The genotype, TCGS-2657 showed better performance for days to 50% flowering, days to maturity, 100-kernel weight, dry haulms yield plant^{-1} **,** number of mature pods plant^{-1} . The genotype,

TCGS-2650 showed better performance for days to maturity, shelling percent, pod yield plant^{-1}, 100-kernel weight, dry haulms yield plant^{-1}. Overall, these promising genotypes could serve as valuable donor parents in groundnut breeding programmes aimed at developing high yielding early maturing and superior cultivar.

Table 4: Promising groundnut genotypes identified for physiological, yield attributes and quality traits.

S.NO	Genotype	Character
1	TCGS-2648	SPAD chlorophyll meter reading at 60 DAS, 100-pod weight, 100-kernel weight, pod yield plant^{-1} ,Kernel yield plant^{-1} , shelling percent, harvest index, protein content.
2	TCGS-2635	Days to 50% flowering, days to maturity, pod yield plant^{-1} ,Kernel yield plant^{-1} , dry haulms yield plant^{-1} , harvest index, oil content.
3	TCGS-2645	Days to 50% flowering, days to maturity, number of mature pods plant^{-1} pod yield plant^{-1} , harvest index, protein content.
4	TCGS- 2657	Days to 50% flowering, days to maturity, number of mature pods plant^{-1} 100-kernel weight, dry haulms yield plant^{-1}
5	TCGS-2650	Days to maturity, pod yield plant^{-1} 100-kernel weight, shelling percent, dry haulms yield plant^{-1}
6	TCGS-2683	Days to 50% flowering, SPAD chlorophyll meter reading at 60 DAS, Specific leaf area at 60 DAS, plant height, number of mature pods plant^{-1}
7	TCGS-2651	Plant height, 100- pod weight, 100- kernel weight, protein content.
8	TCGS-2631	Plant height, Number of primary branches plant^{-1} Number of mature pods plant^{-1} shelling percent , oil content.
9	TCGS-2643	Pod yield plant^{-1} Kernel yield plant^{-1} , dry haulms yield plant^{-1}protein content.
10	TCGS-2660	Number of mature pods plant^{-1} Kernel yield plant^{-1} , shelling percent, dry haulms yield plant^{-1}

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