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RESEARCH PAPER

Evaluation and identification of promising advanced breeding lines for quality and yield traits in groundnut (*Arachis hypogaea* L.)

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Abstract : Kernel size coupled with the nutritional quality will determine the worth of groundnut for direct consumption or export. Focusing on this objective one hundred and fifty advanced breeding lines (ABLs) in both Spanish and Virginia botanical varieties were evaluated with four checks under Augmented Design during *Kharif,* 2018 at ICAR- Directorate of Groundnut Research, Junagadh, Gujarat. Significant difference was observed for days to 50% flowering, hundred pod weight (g), hundred kernel weight (g), sound mature kernel (%), shelling percent, pod weight per plant (g), and protein percent. Pod yield per plant (g) registered highest estimates of GCV and PCV. High heritability coupled with high genetic advance as per cent of mean was recorded for 100 pod weight (g), 100 kernel weight (g), sound mature kernel percentage and pod yield per plant (g) traits which indicates a significant role of additive gene action for inheritance of these traits which may be exploited through simple selection methods. Eleven genotypes *viz*., PBS 19013, PBS 19015, PBS 19018, PBS 29079 B, PBS 29082, PBS 29124, PBS 29167, PBS 29196, PBS 29197, PBS 29212 and PBS 29219 had good confectionery quality traits *viz*., large seed size (HKW: >55 g; KL: >1.5cm and KW: >0.7cm), high protein (>30%), high total soluble sugar (>5 %), moderate oil (42- 48%), uniform pod size and shape, high pod yield per plant (> 10g) and good shelling percentage (>60%). These promising genotypes can directly be released as a variety after testing in multi-location AICRP-G trials or can be used in hybridization programmes as donor parents for improving confectionery qualities in groundnut.

Key Words : Confectionery, Groundnut, Quality, ABLs

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INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is considered as an important oilseed crop throughout the world and having a unique nutritional composition. It is ranked as the second most important cultivated grain legume, third most important vegetable protein and fourth largest edible oilseed crop in the world (Shilman *et al.,* 2011). In India, it covers an area of 5.0 million ha area with the production and productivity of 7.72 million tons and 1537

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kg/ha, respectively during 2015-16 to 2017-18 (Anonymous, 2018).

It is categorized as oil types and confectionary types according to its utilization pattern. In confectionary type groundnut, there are some important trade attributes. New groundnut cultivars should possess certain physical attributes and chemical composition, and maintain some definite processing and end-use characteristics to be acceptable to traders, manufacturers and ultimate consumers. High values for sound mature seeds (SMS) (>80%), 100-seedmass (HSM), kernels with elongated shape, tapering ends and pink to light brown testa colour and large seed size are considered desirable traits (Nigam *et al.,* 1989). Among the physical quality requirements for confectionery groundnuts size, shape, high sound mature kernel (>80%) are important. Chemical qualities like low (<1%) free fatty acid (FFA), high sugars (> 5%) and high protein (>30%) along with nutritional qualities like high O/L, and low oil (<45%) are preferred traits for confectionery groundnuts (Kona *et al.,* 2019, 2020).

With the chronic shortage of pulses and increasing protein energy malnutrition, groundnut has emerged as an important food crop having inexpensive high quality protein, sugar and amino acids and it opens up new vistas in sustaining nutritional security especially among the burgeoning, under nourished, poverty stricken Indian rural population. Hence, more emphasis is given to improve and exploit groundnut as a food crop to make its farming more competitive and remunerative. Heritability is an important parameter because it determines the response to selection. Heritability and genetic advance are very useful biometrical tools for breeders in determining the direction and magnitude of selection. High heritability alone is not enough to make efficient selection in the advanced generations and unless accompanied by substantial amount of genetic advance. The present study was undertaken using 150 advanced breeding lines of groundnut to estimate genetic variability parameters including genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability in broad sense (h2), genetic advance (GA), gene advance as percentage of mean (GAM) for yield and quality traits in groundnut followed by grouping of promising genotypes for each trait.

Material and Methods

Location and Plant material:

The present study was undertaken in *Kharif* 2018 at the research farm of ICAR- Directorate of Groundnut Research, Junagadh, Gujarat, India. The material used in the present study comprised of 154 groundnut genotypes including 150 advanced breeding lines and four check varieties namely BAU 13, GJGHPS 1, Mallika and TKG 19A.

Field design:

The material was evaluated in augmented block design (Federer, 1956). The design consisted of 5 blocks containing 34 genotypes in each with 30 test entries and four check entries replicated in each block. Each genotype was represented by 3 meter row length with 60cm between row and 10cm among the plants. The plants were space planted for optimal expression of traits. Data was recorded from ten randomly selected competitive plants on eleven traits related to yield as well as quality *viz*., days to 50% flowering, hundred pod weight (g), hundred kernel weight (g), sound mature kernel (%), kernel length (cm), kernel width (cm), shelling percent, pod weight per plant (g), oil content (%) (determined by Soxhlet method), protein content (%) (determined by Kjeldhal method) and total soluble sugar content (determined by NIR). In each block the checks were allotted randomly. Recommended package of practices were followed to raise the crop.

2.3 Statistical analysis

The analysis of variance for augmented design and various genetic parameters was performed in R (R core team 2018) using package 'augmentedRCBD' (Aravind, 2019). The genotypic coefficient of variance (GCV) and phenotypic coefficient of variance (PCV) was estimated by the formulae given by Burton (1952). Heritability in broad sense was computed by the formulae given by Lush (1940). From the heritability estimates, the genetic advance over mean was determined as per the procedure of Johnson *et al*. (1955).

Results and Discussion

Analysis of variance (Table 1) revealed significant mean sum of squares for all traits for different sources of variation. All the traits except kernel length and oil percent showed significant variation in block (unadjusted). Kernel length, kernel width, oil percent and total soluble sugar content were non-significant in treatment (adjusted as well as unadjusted) whereas remaining traits *viz*., days to 50% flowering, hundred pod weight, hundred kernel weight, sound mature kernel percent, shelling percent, pod weight per plant, and protein percent were significant. In effect due to checks are significant in all traits except for oil percent and total soluble sugar content. Similarly kernel length, kernel width, oil percent and total soluble sugar content were found non-significant whereas remaining traits were significant due to genotypes effect. However, the adjusted block effects were non-significant for all traits except kernel length, kernel width, oil percent and total soluble sugar content indicating homogeneity of evaluation blocks. Similarly, the mean square due to treatment v/s checks was significant for all the traits except oil percent, indicating thereby that the test entries were significantly different from checks except for oil percent.

The mean values along with range for traits *viz*., days to 50% flowering, 100 pod weight (g), 100 kernel weight (g), sound mature kernel (%), kernel length (cm), kernel width (cm), Shelling percentage, pod yield per plant (g), oil percent, protein percent and total soluble sugar percent were given in Table 2.

The highest estimates of GCV and PCV were registered for pod yield per plant (g) indicating the presence of adequate amount of variation among the genotypes for this trait (Table 2) (Fig 1). High variability estimates for pod yield per plant was similar to the earlier reports (Parameswarappa *et al*., 2005; John *et al*., 2008; Meta and Monpara 2010; Jonah *et al*., 2012 and Patidar *et al*., 2014). Moderate estimates of GCV and PCV were observed for 100 pod weight (g), 100 kernel weight (g) and sound mature kernel percentage which indicated the greater role of environment on genotypes in the expression of variability. These results were in accordance with the earlier findings of Zaman *et al*.,2011, Rao *et al*., 2014 and Ramana *et al*., 2015 for 100 kernel weight (g); John *et al*., 2013 for 100-pod weight.

Low estimates of GCV and PCV were observed for days to 50% flowering, kernel length, kernel width, shelling percentage, oil percent, and protein percent indicating low variability among the tested genotypes for these traits. These results were akin with the findings of John *et al*. (2009), Zaman *et al*. (2011), Kadam *et al*. (2016) and Vasanthi *et al*. (2016) for days to 50% flowering; Kadam *et al*. (2016) for shelling out-turn; Korat *et al*. (2009) for oil content.

High heritability estimates were registered for days to 50% flowering, 100 pod weight (g), 100 kernel weight (g), sound mature kernel percentage, shelling percentage, pod yield per plant (g) and protein percent which indicated that environment had least influence on the expression of these traits (Fig 1). Similar results were also reported by John *et al*. (2009). Low heritability for oil percent and medium for kernel length, kernel width and total soluble sugar percent have been observed in the present study. The maximum value for heritability was recorded for days to 50% flowering (92.22%) and minimum for oil percent (26.22%).

Hundred pod weight (g), hundred kernel weight (g), sound mature kernel percentage and pod yield per plant (g) exhibited higher estimates of genetic advance as per cent of mean which indicated that these traits were governed by additive genes and selection will be rewarding for improvement of such traits. Low genetic advance as per cent of mean was recorded with shelling percentage, kernel Length, kernel width, oil percent and protein percent. To predict the gain under selection, heritability coupled with genetic advance is more important than heritability alone. High heritability coupled with high genetic advance as per cent of mean were

Table 1 : Analysis of variance of augmented block design for eleven traits in 154 genotypes of groundnut

Source of variation	df	DFF	HPW	HKW	KL	KW	OP	PP	PYP	SMK	SP	Total soluble sugar
Blocks (ignoring treatments)	4	1.29**	34.77*	128.13*	0.02	0.01**	15.49	3.73**	7.93*	72.46*	49.52**	5.56**
Treatments (eliminating blocks)	153	1.53**	61.42**	387.16**	0.02	0.0036	6.49	1.15**	5.78*	74.26**	12.42**	0.59
Checks	3	0.53*	370.91**	2484.67**	0.05*	0.02**	8.7	1.25**	17.41**	175.33**	18.99**	0.67
Blocks (eliminating treatments)	4	3.05**	16.22	49.16	0.03	0.0027	1.27	0.24	5.11	74.5*	5.16	1.04
Treatments (ignoring blocks)	153	1.48**	61.9**	389.22**	0.02	0.0038	6.86	1.24**	5.86*	74.21**	13.58**	0.71
Genotypes	149	1.5**	47.1**	289.82**	0.01	0.0034	6.73	1.24**	5.47*	69.68**	13.45**	0.7
Treatment v/s Checks	1	1.81**	1340.26**	8913.72**	0.37**	0.03**	20.09	0.95*	28.27**	445.89**	17.25*	2.33*
Error	12	0.12	9.06	23.79	0.01	0.0017	4.97	0.16	1.74	17.33	2.38	0.42

* and ** indicates significance of values at P < 0.05 and P< 0.01, respectively

recorded for 100 pod weight (g), 100 kernel weight (g), Sound mature kernel percentage and Pod yield per plant (g) traits which indicated significant role of additive gene action for inheritance of these traits and also less influence of environment which may be exploited through simple selection procedures. High to moderate heritability values coupled with low GAM were obtained for days to 50% flowering, kernel length, kernel width, shelling percentage and protein content indicating that both additive and non-additive gene effects are playing an important role in the expression of these characters. Therefore, selection for these characters would not be

Table 2 : Estimates of variability and genetic parameters for 11 traits in 150 advanced breeding lines and four checks

Sr. No.	Character	Mean ± SD	Range		Variance		Coefficient of variation (%)		Heritability (Broad sense)	Genetic Advance (GA)	Genetic advance as per cent of mean (%)
			Min	Max	Phenotypic	Genotypic	Phenotypic	Genotypic			
1.	Days to 50% flowering	27.49 ±1.52	25	31	1.5	1.38	4.45	4.28	92.22	2.33	8.48
2.	100 pod weight (g)	121.26 ± 17.9	73.16	188.49	289.82	266.03	14.04	13.45	91.79	32.24	26.59
3.	100 kernel weight (g)	49.57 ± 7.31	26.06	79.64	47.1	38.03	13.84	12.44	80.76	11.43	23.06
4.	Sound mature kernel percentage	55.9 ± 9.48	32	78	69.68	52.34	14.93	12.94	75.12	12.94	23.14
5.	Kernel length (cm)	1.72 ± 0.14	1.24	1.98	0.01	0.0049	7.04	4.05	33.21	0.08	4.82
6.	Kernel width (cm)	0.89 ± 0.06	0.75	1.05	0.0034	0.0016	6.5	4.53	48.49	0.06	6.51
7.	Shelling percentage	65.84 ± 3.74	52.43	76.52	13.45	11.07	5.57	5.05	82.33	6.23	9.46
8.	Pod yield per plant (g)	9.2 ± 2.63	3.51	19.19	5.47	3.74	25.44	21.01	68.23	3.29	35.81
9.	Oil content (%)	45.76 ± 2.55	40.64	52.51	6.73	1.77	5.67	2.9	26.22	1.4	3.07
10.	Protein content (%)	31.27 ± 1.1	25.78	32.77	1.24	1.09	3.56	3.33	87.43	2.01	6.43
11.	Total soluble sugar content (%)	5.99 ± 0.83	3.32	7.71	0.7	0.28	13.96	8.9	40.62	0.7	11.7

Table 3 : Performance wise list of ABLs under each trait

Sr. No.	Trait	Least performance ABLs	Highest performance ABLs
1.	Days to 50% flowering	25 days : PBS 19012, PBS 19013, PBS 19014, PBS 29229	31 days: PBS 29052, PBS 29096, PBS 29145, PBS 29148, PBS 29174, PBS 29206, PBS 29208
2.	Hundred kernel weight (g)	<39g: PBS 29090, PBS 19019, PBS 29100, PBS 29106, PBS 29077, PBS 29161, PBS 19032	>61g: PBS 29197, PBS 29137, PBS 29212, PBS 29069, PBS 29079B
3.	Hundred pod weight (g)	<90gm: PBS 29201 (86.33), PBS 29090 (86.70), PBS 29220 (88.15), PBS 29161(88.39)	> 145gm: PBS 29082 (145.46), PBS 19029 (145.54), PBS 29193 (147.07), PBS 29136 (147.20), PBS 29212 (150.91), PBS 29137 (154.80), PBS 29069 (176.94), PBS 29079B (188.49)
4.	Kernel Length (cm)	<1.5cm: PBS 29206 (1.24)	>1.9cm: PBS 29197 (1.90), PBS 29212 (1.92), PBS 29189 (1.95), PBS 29079B (1.98),
5.	Kernel width (cm)	PBS 29070 (0.75cm)	PBS 29079A (1.00cm), PBS 29141 (1.00cm)
6.	Oil content (%)	<42%: PBS 29196 (40.64), PBS 29190 (40.77), PBS 29203 (41.12), PBS 29153 (41.19), PBS 29220 (41.25), PBS 29193 (41.33), PBS 29136 (41.38), PBS 29151 (41.55), PBS 29069 (41.60), PBS 29170 (41.73)	>50%: PBS 29160 (50.62), PBS 29090 (50.80), PBS 29137 (51.31), PBS 19030 (51.89), PBS 29163 (52.51)
7.	Protein content (%)	<29%: PBS 29201(25.78), PBS 29202 (26.57), PBS 19030 (26.93), PBS 19012 (28.32), PBS 19022 (28.71)	>32%: PBS 29159 (32.51), PBS 29081 (32.55), PBS 29148 (32.55), PBS 29228 (32.57), PBS 29115 (32.58), PBS 29194 (32.68), PBS 29213 (33.67),
8.	Pod weight per plant (g)	<6gm: PBS 29052 (3.51), PBS 29157 (3.79), PBS 19019 (4.34), PBS 29215 (4.69), PBS 29089 (5.11)	>12gm: PBS 29212 (12.97), PBS 29197 (13.09), PBS 29167 (13.29), PBS 19018 (15.19), PBS 19013 (17.34), PBS 29082 (18.60), PBS 19015 (19.19)
9.	Sound mature kernel (%)	<40%: PBS 29090 (32.00), PBS 29220 (32.00), PBS 29143 (36.00), PBS 29230 (36.00), PBS 29182 (38.00)	>70%: PBS 19023 (70.00), PBS 29194 (70.00), PBS 19025 (71.00), PBS 29175 (71.00), PBS 19021 (72.00), PBS 29071 (72.00), PBS 29069 (75.00), PBS 29210 (75.00), PBS 29136 (78.00)
10.	Shelling Percentage	<60%: PBS 19014 (52.43), PBS 19019 (57.13), PBS 29136 (57.30), PBS 29069 (57.44) PBS 19024 (57.73), PBS 29158 (57.79)	>70%: PBS 29233 (71.86), PBS 29230 (72.35), PBS 29232 (72.78), PBS 29189 (72.89), PBS 29162 (74.89), PBS 29163 (76.52)
11.	Total soluble sugar content (%)	<4.5%: PBS 19012 (3.32), PBS 29163 (3.88), PBS 29168 (4.27)	>7.5%: PBS 29195 (7.51), PBS 29184 (7.53), PBS 29183 (7.57), PBS 29151 (7.69), PBS 19019 (7.71)

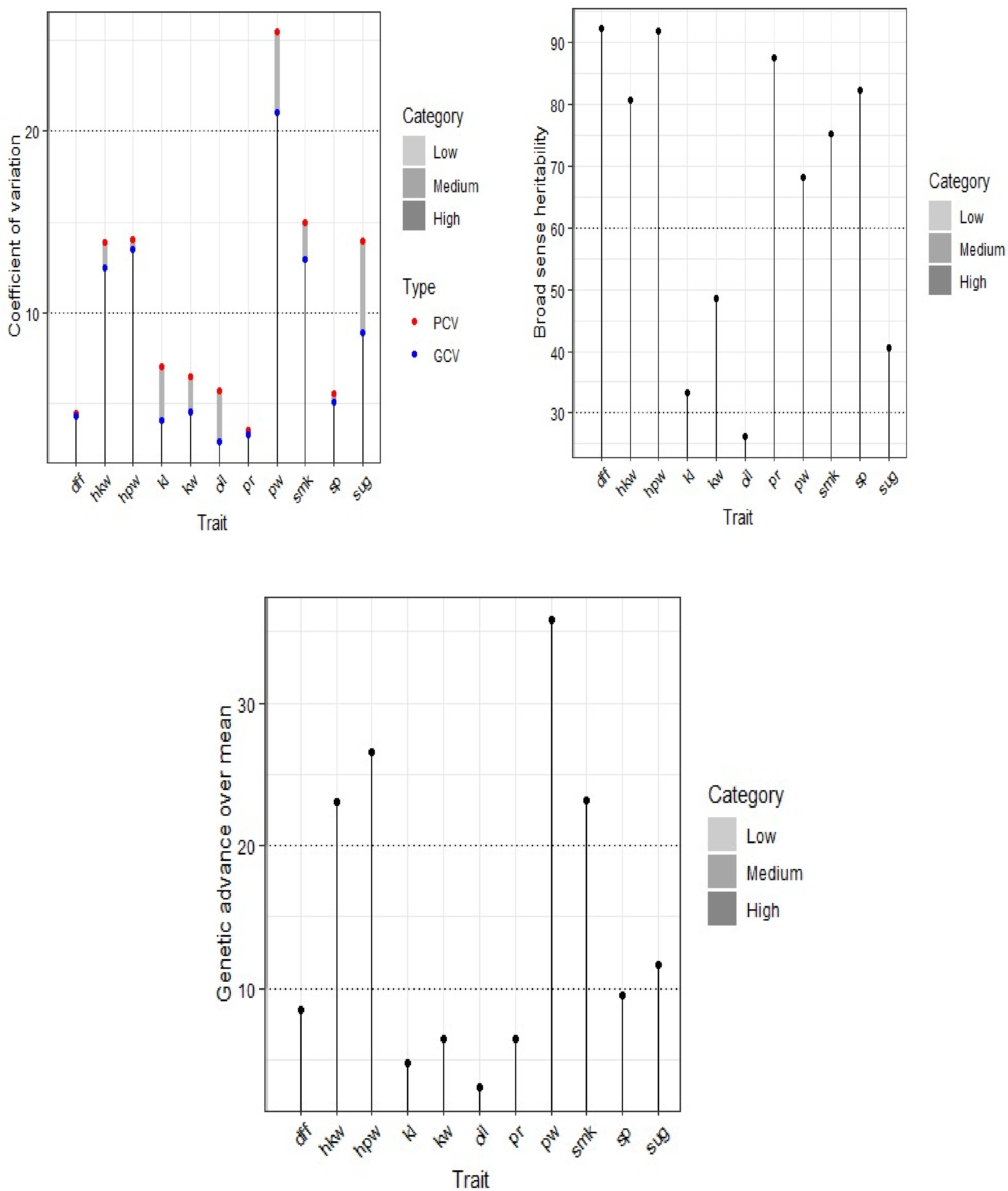

Fig. 1 : Graphical representation of coefficient of variation, heritability and genetic advance over mean for 11 traits in ABLs of groundnut

effective in early segregating generations.

Grouping the genotypes on performance wise for each trait in order to identify the best genotypes for confectionery purpose (Table 3) revealed that genotypes, PBS 19012, PBS 19013, PBS 19014, and PBS 29229 taken <25 days to 50 % flowering whereas genotypes, PBS 29052, PBS 29096, PBS 29145, PBS 29148, PBS 29174, PBS 29206 and PBS 29208 had taken 31 days for 50 % flowering (Table 3.)

Two genotypes *viz*., PBS 29079 B and PBS 29069 were larger in size (>70g hundred kernel weight) and were found superior over checks. PBS 29079B (79.6 g) followed by PBS 29069 (70.2 g), PBS 29212 (63.5 g), and PBS 29137(61.0 g) recorded highest HKW whereas PBS 29090 (31.0 g) followed by PBS 19019 (34.8 g), PBS 29100 (35.5 g) and PBS 29106 (37.2 g) recorded lowest HKW.

PBS 29079B (188.5 g) followed by PBS 29069 (176.9 g), PBS 29137 (154.8 g) and PBS 29212 (150.9 g) recorded highest HPW whereas PBS 29201 (86.3 g) followed by PBS 29090 (86.7 g), PBS 29220 (88.1 g) and PBS 29161 (88.4 g) genotypes recorded lowest HPW.

The kernel length (KL) varied from 1.24cm (PBS 29206) to 1.98cm (PBS 29079 B) whereas kernel width (KW) was in a range of 0.75cm (PBS 29070) to 1.05cm (PBS 29153). Kernels were longer in PBS 29079 B (1.98cm) and larger kernel width was in PBS 29153 (1.05cm). The oil content varied from 40.64% (PBS 29196) to 52.51% (PBS 29163) and protein content varied from 25.78 (PBS 29201) to 33.67% (PBS 29213). The genotype, PBS 29163 recorded highest shelling percentage (76.5 %) followed by PBS 29162 (74.9 %). The genotype, PBS 19015 recorded highest pod yield / plant (19.2 g) followed by PBS 29082 (18.6 g) and PBS 19013 (17.3 g).

Conclusion:

Eleven genotypes *viz*., PBS 19013, PBS 19015, PBS 19018, PBS 29079 B, PBS 29082, PBS 29124, PBS 29167, PBS 29196, PBS 29197, PBS 29212 and PBS 29219 had good confectionery quality traits *viz*., large seed size (HKW: >55 g; KL: >1.5cm and KW: >0.7cm), high protein (>30%), high total soluble sugar (>5 %), moderate oil (42- 48%), uniform pod size and shape, high pod yield per plant (> 10g) and good shelling percentage (>60%). Further validation for these traits at multi-locations would result in identification of promising genotypes which can be released as a variety or can be used as donor parents in hybridization programmes for improving confectionery qualities in groundnut.

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