Variation in blanchability in Virginia groundnut (*Arachis hypogaea* L.)

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ABSTRACT

Blanchability is ease of testa /skin removal and cleaning of the groundnut (*Arachis hypogaea* L.) kernel surface. It is a trait of economic importance in processed groundnut food products. The blanching conditions of pre-heating temperature of 110°C for 35 min, with 200 g kernel sample at a blanching time of 2 min and blanching air pressure of 17.6 psi, which gave satisfactory results, were standardized. Ten Virginia bunch large-kernel groundnut varieties grown in 2007 rainy season and 2007/08 postrainy season at the ICRISAT Centre were evaluated for their blanchability. There was large variation in total blanchability among the genotypes, ranging from 14 to 60% in the rainy and 35 to 55 % in the postrainy season. ICGV 03137 (60% in rainy season and 54% in postrainy season) had the maximum total blanchability. The whole kernel blanchability was also the highest (>40%) with <3% unblanched splits in ICGV 03137 in both the seasons. No physical (100-kernel weight, kernel length, width and length to width ratio) or chemical (oil and protein contents) trait was associated with blanchability parameters (total blanchability, whole blanched kernels and fully blanched splits) in the 2007 rainy season. However, in the 2007/08 postrainy season, oil content showed positive and protein content and kernel length negative association with blanchability parameters. Preliminary studies by other workers indicate that blanchability character gets fixed in early generations. It is, therefore, important to select parents carefully with high blanchability in a confectionery breeding program to ensure that progenies have high probability of retaining high performance for the trait.

Keywords: Confectionery trait, Seed testa, Virginia groundnut

Groundnut (*Arachis hypogaea* L.) is a multi-purpose crop used for food, edible oil, feed for livestock, and industrial raw material. Globally, over half of the groundnut produced is crushed into oil for human consumption and slightly less than 40% is used directly as food. However, the pattern of utilization varies widely across the regions. In North and Central America, over 75% of the production is used as food while in Asia only 35% is used for the same purpose. Thus, breeding groundnuts for confectionary traits is important, to meet the growing domestic groundnut demand for food purposes in the country and to harness the International trade of confectionary groundnuts for the benefit of groundnut farmers of the developing countries.

Blanchability is the capacity of a groundnut genotype to recover kernels with all the testa removed. It is a confectionery trait of economic importance in processed groundnut food products, which include peanut butter, salted groundnuts, candies, bakery products, groundnut flour and others. If a groundnut cultivar has poor blanchability, the cost of processed food increases as more efforts are needed to remove the skin from kernels. Blanching treatment gives a whiter and more homogeneous appearance to groundnut products. This process further enhances the product quality, as it subjects the kernels to an additional pre-cleaning and sorting stage. Removal of the groundnut skin facilitates electronic eye sorter detection of any damaged kernels which may have been concealed by the skin and therefore not previously visible under regular cleaning and sorting procedures. Blanching of kernel followed by removal of damaged or discolored kernels using electronic color sorter reduces aflatoxin in all market types and grades of groundnut (Whitaker, 1997). The skins are removed from groundnut kernels by a combination of different processes: drying, heating, rubbing between hard and soft surfaces, and blowing a current of air through them. The rate of heating or drying of groundnuts during blanching as well as the rate of cooling is important in maintaining crispiness and white color. Rapid heating and quick cooling gives a much more crisp and white appearance; while prolonged heating causes the oil to flow throughout the tissue which becomes translucent in color and gummy when crushed. Blanchability of groundnut kernel is affected by genotype, kernel grade and harvest date (Mozingo, 1979) and pre-treatment of kernels (Farouk *et al.*, 1977).

Blanchability remains a neglected trait in most of the breeding programs in developing countries. However, at the processors' level, where commercial blanchers are used, it is an important economic trait. Often an otherwise good cultivar receives discounted price in the market to compensate the increased cost of blanching if the blanchability of a cultivar is poor. This discourages farmers to grow such cultivars. For programs engaged in breeding groundnut for food use, blanchability should be a regular trait in evaluating the performance of advanced breeding lines. Several laboratory-scale blanchers have been fabricated to assist the breeding programs (Barnes Jr. *et al.*, 1971, Wright and Mozingo, 1975, Hoover, 1979 and Singh *et al.*, 1996). The American Society of Agricultural and

Biological Engineers (ASABE) in 2006 published the following protocol for determining blanchability using laboratory blancher developed by Wright and Mozingo (1975): kernel sample weight 250 g, pre-heating at 200°C for 9 min (the pre-heat should lower the kernel moisture content between 3.75-4.0%) and then allow to cool to room temperature, blanching duration 180±25 sec for extra-large kernels and 240±25 sec for medium size kernel and air pressure at 121±0.5 kPa (17.6 ± 0.1 psi).

The present experiment was aimed to study variation in blanching traits among 10 large-kernel Virginia groundnut advanced breeding lines and to identify the best genotype(s) for use in breeding programs.

MATERIALS AND METHODS

Blanching protocol was standardized using a bulk sample of large-kernel (kernel moisture content 5.2% and 100-kernel weight 97 g) Virginia groundnut variety, ICGV 98426, which was grown in the postrainy season. A laboratory type blancher, based on the model developed by Wright and Mozingo (1975), was fabricated at ICRISAT Center (Singh *et al.*, 1996). Blanching conditions such as heating temperature and time before blanching (pre-heating), blanching time, air pressure and quantity of sample were standardized. Initially, blanching protocol of Wright and Mozingo (1975) was followed. But at 200°C temperature, the groundnut kernels got overheated. We tried a range of temperature from 76°C to 200°C for 9 min, but within these parameters either a sample did not blanch properly or the sample got overheated. Then, we followed the temperature protocol (pre-heating temperature of 100°C for 35 min with a sample weight of 250 g) used by Cruickshank *et al.* (2003) with an Ashton abrasive-roller blanching unit. However, this protocol resulted in only 65% of totally blanched kernels. By increasing the pre-heating temperature to 110°C for 35 min and reducing the weight of sample to 200 g, the per cent total blanched kernel increased to 92%. Thus, for the present experiment, a pre-heating temperature of 110°C for 35 min, with 200 g sample for blanching time of 2 min and blanching air pressure of 17.6 psi was standardized.

Blanchability trait was studied in the kernel samples of 10 different large-kernel Virginia groundnut genotypes grown in two cropping seasons. Two controls, ICGV 86564 (popular large-seeded variety from ICRISAT) and Somnath (national large-seeded control in India), were included in the experiment. The experiment was laid out on raised beds in an Alfisols field in a randomized block design with two replications during the 2007 rainy season (R 07) and with three replications in the 2007/08 postrainy season (PR 07/08) at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT, 17° 30' N; 78° 16' E; altitude 549 m), Patancheru. The plot size was four rows of 4 m length. A distance of 30 cm between rows and 10 cm between plants within a row was maintained. P_2O_5 @ 60 kg/ha was applied basally and gypsum @ 400 kg/ha was top dressed at peak flowering stage followed by intercultivation. The experiment was kept weed free by application of pre-emergence herbicide Alachlor @ 4 L/ha and two manual weedings. The crop was regularly monitored for diseases and insect pest incidence in both the seasons and necessary chemical sprays were carried out to protect the crop. During the rainy season, the experiment received 6 irrigations and in the postrainy season 15 irrigations to avoid moisture stress to the crop. It took 135 days in the rainy season and 145 days during the postrainy season for the crop to reach maturity. After harvest, the produce was shade-dried, pods were shelled and kernels were stored at room temperature (20±1°C) until blanching.

In both rainy and postrainy season, observations on the pod yield, kernel yield, shelling outturn, 100-kernel weight, kernel length and width, oil content, protein content and oleic/linoleic fatty acid ratio were taken in all the 10 genotypes and controls. In the postrainy season, the kernels were graded and sound mature kernel (SMK) yield of grade 1-3 kernels (described later) was recorded. Kernel length and width were an average of twenty randomly selected grade 1 kernels. During the rainy season, blanching studies were carried out after storing the kernel for 3-4 months, but in the postrainy season, the studies were carried out soon after harvest and drying. The first grade kernel of each variety (200 g) was used for blanching studies. For this control, a pooled sample of all the three replications was used. The percentage of total blanched (TB, includes fully blanched intact kernels and fully blanched splits), whole blanched (WB, fully blanched intact kernels), whole unblanched (UB, unblanched intact kernels), partially blanched (PB, partially blanched intact kernels), blanched splits (SB, fully blanched splits) and unblanched splits (UBS) were determined on weight basis. Nuclear magnetic resonance (NMR) was used for oil estimation. The protein content was analyzed using a Technicon autoanalyser II (Technicon industrial systems, Tarrytown, New York). Using gas chromatography (GC) oleic and linoleic fatty acid contents were estimated.

In the rainy season, blanching tests were carried out with ungraded kernel samples. However, in the postrainy season, where yields were high and kernel size was large (and associated variation in seed size was more), the kernels were graded to eliminate the effect of varying seed size on blanchability. Kernels were graded using a mechanized grader with different sieve sizes as per US standard grades (extra-large grade: rides over 20/64 x 1 inches screen; medium grade: rides over 18/64 x 1 inches, No. 1 grade: rides over 15/64 x 1 inches screen and No.2 17/64 inches round screen) (NPCA, 1988). Extra-large kernels were used for the blanchability study in the postrainy season.

Data from individual seasons were analyzed using GENSTAT (8.0 Version) separately and summary statistics were tabulated. Angular transformed values were used for analysis. As sufficient quantity of grade 1 kernel in Somnath was not available in the 2007/08 postrainy season, the grade 1 kernels from two replications were pooled and the third replication, where no grade 1 kernel was available, was treated as missing value.

RESULTS AND DISCUSSION

The standardized blanching protocol included 200 g kernel sample, pre-heating temperature of 110ºC for 35 min, blanching time of 2 min and blanching air pressure of 17.6 psi. The protocols standardized earlier (Barnes *et al.*, 1971 and Singh *et al.*, 1996) also reported satisfactory laboratory blanching by operating the device for 120 sec at 17.6 psi pressure.

As observations on blanchability parameters were recorded in different manners (on bulk kernel sample in the 2007 rainy season and on grade 1 kernel in the 2007-08 postrainy season) in both the seasons, no pooled analysis was carried out. The data for both the seasons were analyzed separately. Genotypes differed significantly for all the six blanchability parameters in both the seasons (Table 1). The genotypes also differed in moisture loss during blanching. In spite of apparent uniform drying/storage conditions, genotypes retained different levels of moisture in kernels. The total blanchability (TB%) among genotypes ranged between 14 and 60.4% (average 34.3%) in the rainy season and between 35 and 62.5% (average 46.3%) in the postrainy season. The lower shelling turnover (SH%) and 100 seed weight (HKW) in the rainy season reflect poor seed development (shriveling of seeds), which might have contributed towards lower TB. In a study conducted on 35 Spanish and 45 Virginia genotypes, a high range for total blanchability in Spanish (10.8% - 90.6%) and Virginia (8.6-86.7%) types was observed (Singh *et al.*, 1996).

Table 1 Blanchability parameters of advanced Virginia breeding lines of groundnut during the 2007 rainy season (R 07) and the 2007/08 postrainy season (PR 07/08), ICRISAT, Patancheru, India

Genotype	MOL (%)		WBL (%)		UBL (%)		PBL (%)		SBL (%)		USBL (%)		TB (%)	
	R 07	PR 07/08	R 07	PR 07/08	R 07	PR 07/08	R 07	PR 07/08	R 07	PR 07/08	R 07	PR 07/08	R 07	PR 07/08
ICGV 01369	10.8	11.3	8.8	24.5	46.7	36.0	24.2	21.9	15.7	28.6	10.4	9.4	18.2	40.2
	(3.5)	(3.9)	(2.6)	(18.7)	(53.0)	(34.6)	(17.4)	(13.9)	(7.5)	(23.1)	(6.3)	(4.6)	(10.1)	(41.8)
ICGV 01395	9.8	10.8	22.8	24.4	31.2	36.57	28.3	19.0	28.6	32.4	14.9	7.8	38.1	42.7
	(2.9)	(3.5)	(15.1)	(17.2)	(27.0)	(35.5)	(22.5)	(10.8)	(23.0)	(28.8)	(6.7)	(2.9)	(38.1)	(46.0)
ICGV 01432	10.6	12.8	8.7	24.7	49.3	35.8	29.0	15.0	10.9	30.1	16.6	9.3	14.0	41.7
	(3.4)	(4.9)	(2.3)	(18.2)	(57.3)	(34.9)	(23.9)	(9.9)	(3.7)	(26.1)	(8.5)	(4.1)	(6.0)	(44.4)
ICGV 01434	10.8	11.8	11.2	23.9	45.2	31.8	31.3	29.9	11.0	24.6	18.2	15.4	15.8	35.8
	(3.6)	(4.2)	(4.0)	(16.7)	(50.4)	(27.9)	(27.2)	(25.7)	(4.1)	(17.6)	(9.7)	(7.0)	(8.1)	(34.3)
ICGV 05168	10.3	12.0	32.2	31.7	33.9	25.8	22.1	16.6	23.0	36.8	10.5	8.2	41.5	53.1
	(3.2)	4.3)	(28.3)	(28.0)	(31.6)	(19.0)	(14.6)	(8.3)	(15.6)	(35.9)	(3.4)	(3.1)	(43.9)	(63.9)
ICGV 03136	9.7	11.5	24.2	28.9	40.0	26.8	21.6	12.7	23.9	41.1	14.8	2.99	35.3	54.8
	(2.9)	4.0)	(16.9)	(23.4)	(41.3)	(20.4)	(13.8)	(7.1)	(16.5)	(43.2)	(6.7)	(0.8)	(33.3)	(66.6)
ICGV 03137	10.2	12.1	48.6	41.3	21.49	19.9	12.6	11.2	25.8	26.9	0.0	2.6	60.4	54.1
	(3.2)	(4.6)	(56.3)	(44.2)	(13.5)	(14.2)	(4.9)	(5.8)	(19.1)	(21.1)	(0.0)	(0.6)	(75.4)	(65.3)
ICGV 05191	10.4	11.1	20.2	37.2	42.5	33.1	29.3	14.4	15.0	22.4	15.2	6.47	25.8	46.0
	(3.3)	(3.7)	(12.0)	(36.6)	(45.8)	(30.1)	(24.6)	(9.1)	(6.9)	(15.1)	(7.1)	(1.9)	(18.9)	(51.7)
ICGV 05195	9.3	11.6	18.1	30.5	36.1	25.5	28.5	17.7	23.0	37.6	19.6	6.5	30.1	52.7
	(2.6)	(4.1)	(9.7)	(25.8)	(34.8)	(19.1)	(22.8)	(9.6)	(15.4)	(37.3)	(11.7)	(2.1)	(25.1)	(63.1)
ICGV 05200	10.3	11.7	15.7	23.2	41.7	43.2	25.9	20.0	20.8	24.6	19.7	9.1	26.5	35.0
	(3.2)	(4.1)	(7.3)	(15.6)	(44.4)	(46.8)	(19.1)	(11.7)	(12.7)	(17.4)	(11.7)	(4.1)	(20.0)	(33.0)
Controls														
*Somnath	9.5	7.2	35.81	59.2	30.1	21.3	19.8	-	28.0	21.6	0.0	-	48.8	62.5
	(2.7)	(1.4)	(34.3)	(73.0)	(25.2)	(13.4)	(11.6)		(22.3)	(13.2)	(0.0)		(56.6)	(78.0)
ICGV 86564	9.5	11.4	41.4	28.9	20.8	26.2	17.1	18.9	31.6	31.4	2.9	6.1	57.7	46.9
	(2.7)	(3.9)	(43.8)	(24.4)	(12.6)	(20.0)	(8.8)	(16.7)	(27.5)	(28.9)	(0.5)	(3.3)	(71.3)	(53.2)
GM	10.1	11.3	23.97	31.5	36.6	30.2	24.2	16.3	21.4	29.8	11.9	6.7	34.3	46.3
	(3.1)	(4.0)	(19.4)	(25.7)	(36.4)	(27.1)	(17.6)	(11.3)	(14.5)	(26.4)	(6.0)	(3.0)	(33.9)	(52.1)
LSD at 5% level of significance	1.8	2.14	7.01	10.3	8.5	11.34	8.15	16.79	2.78	11.39	9.6	10.1	6.7	14.8
	(1.11)	(1.61)	(9.1)	(15.7)	(14.5)	(16.8)	(10.9)	(15.9)	(3.72)	(17.8)	(7.2)	(5.7)	(8.8)	(24.4)
CV (%)	8.2	11.2	13.3	19.2	10.5	22.1	15.3	60.4	5.9	22.4	36.8	89.4	8.9	17.8
	(16.3)	(22.4)	(21.4)	(34.0)	(18.1)	(34.4)	(28.2)	(78.2)	(11.6)	(37.6)	(54.6)	(103.4)	(11.9)	(26.1)

* In the absence of sufficient quantity of Grade I kernel in each replication, first grade kernel from all replications was pooled to carry out blanchability experiment.

MOL: Moisture lost during blanching, WBL: whole blanched intact kernels; UBL: Unblanched intact kernels; PBL: Partially blanched intact kernels; SBL: Fully blanched splits; UBSL: Unblanched splits; TB : Total blanchability; Note-Numbers in parenthesis are angular transformed values.

Whole blanched intact kernels (WBL%) are fancied and have visual appeal. In some confectionery products such as groundnut with chocolate coatings, fully blanched whole seeds are required. Like TB%, the WBL% was also affected by the season. In the postrainy season more intact fully blanched kernels were recovered (31.5%) compared to the rainy season (24.0%). Among the advanced breeding lines, genotype ICGV 03137 had high WBL% in both the seasons. This genotype also had low proportion of UBL in both the seasons. Genotypes such as ICGV # 01369, 01432, 01434 and 05200, which had higher proportion of UBL, will add to the processing cost if they are to be used in a blanched form. The same will happen with genotypes with higher partially blanched kernels. On average, more fully blanched splits were recovered in the postrainy season than in the rainy season. The greater HKW and better kernel development in the former season might have resulted in higher full blanching and as well as splits. Diener *et al.* (1982) noted that blanching followed by photoelectric color sorting and hand picking provides a reliable method to remove *Aspergillus flavus*/aflatoxin contaminated kernels from the lot. Blanched splits, after photoelectric color sorting, are preferred for peanut butter and other processed peanut food preparations, as they permits easy removal of germs and also have reduced or nil aflatoxin contamination. Genotypes ICGV 03136 (41%) and ICGV 05168 (36.8%) in the postrainy season and ICGV 01395 (28.6%) and ICGV 03137 (25.8%) in the rainy season gave the highest percentage of blanched splits. These genotypes would be suitable for candies and peanut butter preparation. As reported by Farouk *et al.* (1977) and Singh *et al.* (1996) in their studies, the influence of growing season on the blanching quality of groundnut genotypes was also evident in our study.

Commercially, kernel is initially graded before being blanched. The postrainy season kernel was graded with the sieves of different sizes as per US standard grades (NPCA, 1988). The mean quantity of grade 1 kernel obtained (1102 kg/ha) was significantly higher than the quantities in grades 2 and 3 (Table 3). The percent recovery of grade 1 kernel was high in test genotypes. ICGV 01395 (79%), ICGV 05200 (73%), ICGV 03136 (72%), ICGV 01434 (70%) and ICGV 01432 (66%) recorded significantly superior recovery of grade 1 kernel over the best check ICGV 86564 (50%). Grade 1 kernel with higher HKW is preferred for table purposes. The test entries recorded high HKW (91 g -108 g) for the grade 1 kernel. ICGV 01395 (Grade 1 kernel yield 1689 kg/ha and HKW 91 g), ICGV 05200 (Grade 1 kernel yield 1591 kg/ha and HKW 96 g) and ICGV 01432 (Grade 1 kernel yield 1392 kg/ha and HKW108 g) are suitable for the table purpose (Table 3).

Table 2 Performance of groundnut breeding lines during the 2007 rainy season at ICRISAT, Patancheru, India

Genotype	PYD (kg/ha)	KYD (kg/ha)	SH (%)	HKW (g)	OIL (%)	PRO (%)	O/L	KL (cm)	KW (cm)	KL/W
ICGV 01369	1850	1131	62	53	42	22	1.61	1.8	0.85	2.12
ICGV 01395	2706	1739	64	52	43	20	1.34	1.6	0.90	1.78
ICGV 01432	2028	1314	65	52	44	22	1.87	1.75	0.85	2.06
ICGV 01434	2161	1341	62	50	41	21	1.6	1.75	0.85	2.06
ICGV 05168	2367	1491	63	57	44	21	1.3	1.75	0.85	2.06
ICGV 03136	2322	1505	64	58	40	20	1.61	1.7	0.9	1.89
ICGV 03137	1617	1041	64	48	48	18	1.41	1.6	0.8	2.01
ICGV 05191	2378	1538	65	54	41	21	1.38	1.6	0.85	1.89
ICGV 05195	1511	989	65	51	43	24	1.77	1.7	0.8	2.13
ICGV 05200	2889	1834	63	61	43	20	1.34	1.6	0.9	1.94
Controls										
Somnath	1667	1068	65	41	46	21	2	2	1	2.14
ICGV 86564	2450	1696	70	51	46	20	2	2	1	1.89
GM	2162	1391	64.36	52.33	43.33	21.03	1.57	1.675	0.85	1.99
SE	209.1	133.7	1.25	1.79	1.26	0.50	0.10	0.074	0.07	0.09
CV	11.85	11.77	2.36	4.18	3.55	2.9	8.03	5.36	9.2	5.61
LSD	460.3	294.2	2.74	3.93	2.77	1.09	0.23	0.16	0.13	0.20

The oleic (O)/ linoleic (L) fatty acid ratio is an indicator of shelf-life of groundnut products. Although the differences for O/L ratio among the genotypes were significant, they were marginal and all genotypes had an O/L ratio value of 2. High protein content is desirable in groundnut used for direct consumption and in confectionery products. Similarly, low oil content (low calorific value) is favoured in genotypes meant for direct consumption. The data on these traits are given in table 2 and 3. In both rainy and postrainy season, the protein content of the genotypes, ICGV 05195 (24% and 27%), ICGV 01369 (22% and 24%) and ICGV 01432 (22% and 24%) was significantly high. All the tested genotypes recorded <45% oil content in rainy season except ICGV 03137 (48%). In the postrainy season, the range of oil content between genotypes was 42% to 46%.

Agronomic performance of ten genotypes in rainy and post rainy seasons is given in tables 2 and 3. The test genotypes in general yielded on par with the best check in both rainy and postrainy seasons. The contribution of grade 1 kernel to the SMK yield was significantly superior in test genotypes (>57% in seven genotypes) over the best check (50%). Mean pod (by 948 kg/ha) and kernel yield (by 768 kg/ha), HKW (by 20 g) and protein content (by 3%) were higher in the postrainy season compared to the rainy season.

Kernels were more elongated in the rainy season than in the postrainy season (Tables 2 and 3).

The capacity to select for improved blanchability in a confectionery breeding program is essential for economic reasons. Based on their limited genetic data, Shokraii *et al.* (1985) reported dominant or semi-dominant nature of poor blanchability. From their study on blanchability in early generation breeding materials, Cruickshank *et al.* (2003) that early generation selection for blanching (%) was very effective and genes conferring better blanchability were fixed early. Thus, the parents selected for hybridization should have high blanchability to ensure that resultant progenies are also high in the trait. Mozingo (1979) also came to the similar conclusion from his study. Further, this is also important as the selection for blanchability cannot be done on a single plant basis due to significant kernel quantity requirement for blanching test.

Table 3 Performance of groundnut breeding lines during 2007/08 post rainy season at ICRISAT, Patancheru, India

Genotype	PYD (kg/ha)	KYD (kg/ha)	SH (%)	HKW (g)	OIL (%)	PRO (%)	SMK (kg/ha)	SMK yield (kg/ha)			IMK (kg/ha)	SMK yield (%)			IMK (kg/ha)	GR 1 HKW	GR 1 KL (cm)	GR 1 KW (cm)	KL/W	O/L
							Total	GR 1	GR 2	GR 3	GR 4	GR1 (%)	GR2 (%)	GR3 (%)	GR 4 (%)					
ICGV 01369	3594	2150	66	79	45	24	1890	1187	276	427	260	63	15	23	12	104	2	1.09	1.68	1.85
ICGV 01395	4267	2417	66	64	46	22	2142	1689	241	213	274	79	11	10	11	91	2	1.07	1.56	1.43
ICGV 01432	3922	2424	68	79	46	24	2067	1392	269	406	357	66	13	21	15	108	2	1.14	1.68	1.71
ICGV 01434	4017	2616	68	80	45	24	2211	1543	325	342	406	70	15	15	17	105	2	1.29	1.50	1.71
ICGV 05168	3450	2004	69	78	44	20	1624	789	271	565	380	49	17	35	18	99	2	1.11	1.75	1.20
ICGV 03136	3928	2419	66	66	44	24	1766	1277	220	268	653	72	13	16	27	95	2	1.12	1.74	1.64
ICGV 03137	3972	2304	67	73	46	22	1904	946	333	625	399	47	17	36	17	96	2	1.07	1.82	1.34
ICGV 05191	3406	2024	67	76	42	25	1624	1023	237	364	400	63	15	22	20	99	2	1.13	1.66	1.30
ICGV 05195	3172	1738	68	80	44	27	1541	853	247	440	198	55	16	29	11	103	2	1.06	1.66	1.92
ICGV 05200	3972	2406	70	79	44	24	2125	1591	273	262	281	73	14	13	12	96	2	1.06	1.77	1.65
Somnath	3356	1454	61	51	45	23	1142	136	121	886	312	11	11	78	22	83	1	0.75	1.82	1.49
ICGV 86564	3450	1958	67	69	46	23	1557	798	245	514	401	50	15	35	21	95	2	1.10	1.75	1.67
GM	3709	2159	67.31	72.64	45.3	23.9	1799	1102	254.7	442.6	360.1	58.2	14.17	27.63	16.9	98.19	1.83	1.08	1.70	1.58
SE	448.4	336.4	4.09	10.84	1.05	0.76	296.3	262.7	62.87	123.9	133.7	7.62	2.146	8.036	5.274	5.14	0.07	0.07	0.11	0.09
CV	14.81	19.08	7.45	18.27	2.85	3.93	20.16	29.2	30.23	34.28	45.47	16.0	18.54	35.62	38.22	6.418	4.57	8.14	8.27	7.36
LSD	986.9	740.4	9.01	23.86	2.32	1.69	652	578.2	138.4	272.7	294.3	16.7	4.723	17.69	11.61	11.33	0.15	0.15	0.25	0.20

PYD: Pod yield; KYD: Kernel yield; SH: Shelling percentage; HKW: Hundred kernel weight; PRO: Protein; SMK: Sound mature kernel yield; IMK: Immature kernel yield; GR1: Grade 1; GR2: Grade 2; GR3: Grade 3; GR 4: Grade 4; GR1 HKW: Grade 1 hundred kernel weight; GR1 KL: Grade 1 kernel length; GR1 KW: Grade 1kernel width; SD L/W: Kernel length, width ratio; O/L: ratio of oleic to linoleic fatty acid

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