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Studies on morphological characterization in pigeonpea [*Cajanus cajan* (L.) Millsp] germplasm of Chhattisgarh

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Abstract

Pigeonpea [*Cajanus cajan* (L.) Millsp] ($2n=22$) is an important pulse crop that provide food fodder and variable sources of proteins for poor smallholder farmers in the semi-arid tropics and it can survive in dry environments (Damor *et al.*, 2016; Khoiriyah *et al.*, 2017). In this study 104 germplasm were evaluated and morphological characterization are carried out by visual observation on the basis of DUS characterization, which was conducted in Augmented Randomized Complete Block Design (RBD) with 4 blocks during kharif 2020-2021 at College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. The observation are recorded on five randomly selected plants in each genotype for the following 15 qualitative traits viz., Anthocyanin colour on hypocotyls, Flower pattern of streaks on petal, Pod constriction, Pod pubescence, Plant branching pattern, Stem colour, Pod colour, leaf shape, Leaf pubescence on lower surface of the leaf, Pod surface stickiness, Colour of flower base of petal, Plant growth habit, seed colour, seed colour pattern seed shape. The qualitative characters showed wide variation and the potential germplasm may be utilized for further breeding program.

Keywords: Genotype, pigeonpea, genetic diversity, germplasm, qualitative

Introduction

Pigeonpea [*Cajanus cajan* (L.) Millsp] ($2n=22$) is an important pulse crop which occupies as a major place in Indian agriculture. The seed of pigeon pea is eaten as a green vegetable and dry pulse and is an important source of protein, vitamin B, carotene, and ascorbic acid (Odeny 2007, Choudhary *et al.* 2013) ^[10, 2]. According to Varshney *et al.* (2010), pigeon pea seeds have 20-22% protein. It is generally planted by smallholder farmers in low input and rainfed conditions (Khoury *et al.* 2015) ^[6]. Pigeonpea is an often cross-pollinated (20-70%) crop (Saxena, 2006) ^[11]. Pigeonpea is from the family of 'Fabaceae' and is also recognized as 'Arhar' or 'Tur', usually consumed as *dal* and with rich in dietary protein and nourishment minerals and consumed by almost all Indians. The stem of pigeonpea is used for making local brooms (Kharhara) and baskets. The dry stem of pigeonpea is used as firewood, hedge (badi) and chhani (roof of the hut) in tribal villages. Pigeonpea has an inimitable venue in Indian rural agriculture and India grosses for around 90% of total cultivation. Pigeonpea are most essential legume crop following to chickpea in India. In India, Pigeonpea cultivation is not just the key protein food but also very closely interlinked with the revenue and culture of millions of people and added the status symbol of life, so the "Pigeonpea is widely consumed in the form of *dal* as an economical source of protein." is most suitable in Indian perspective. It plays a key role in food security, balanced diet subsistence agriculture because of its diverse usage in food, fodder, soil conservation, integrated farming systems and symbiotic nitrogen fixation. Its roots help deliver soil-bound phosphorus to generate it offered for plant development (Arihara *et al.* 1990) ^[1]. We know that root of pigeonpea breakdown rocks that containing-phosphate to provide P available for plant help (Ae *et al.*, 1990) ^[1]. India has crossed the alarming 'one billion' population mark and it is catching up fast the most populous country i.e., China providing significant quantity of quality food to the growing population with limited resources is a big challenge. Characterization has an important role in crop improvement program. To combine the traits in hybridization program and how a newly developed variety is distinct from the existing one can be confirmed through morphological characterization and their comparison. Morphological characterization of monogenic or qualitative traits showed stable performance across the environments whereas polygenic or quantitative traits did not showed stable expressions.

Although pigeonpea improvement through conventional breeding and hybrid technology is on-going, molecular breeding should accelerate utilization of the substantial variability among the pigeonpea landraces and germplasm lines for various morphological, physiological, and agronomic traits.

Methods and Materials

Experimental site and period of experiment

The research was carried out at Research together with Instructional Training Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, and Chhattisgarh throughout *Kharif* 2020-21. Research place Chhattisgarh are located on 17°14'N and 24°45'N latitudes and 79°16' E and 84°15'E longitudes. capital of the Chhattisgarh state are Raipur and its lies on 21°16'N latitude and 81°36' E longitude with an altitude of 289.60 meters above the mean sea level and the latitude and longitude of experiment field projected at 19° 4'0' N and 82° 2'0' E, respectively.

Experimental season and climatic condition

The area falls underneath central India Hill region and Eastern Plateau (Agro-climatic zone-7) of Chhattisgarh state. It's categorize three parts, were Raipur comes under the Chhattisgarh Plains Zone. Climatic condition of Raipur has a dry sub-humid to semi-dry with 1200-1400 mm average annual rainfall, from the total nearly 85 per cent occurs during rainy season (June to September) and 7-8 per cent remaining received post monsoon duration (October to February). During summer month maximum temperature about high as 48.1°C and during winter (December) minimum occurs at 6°C low temperature. The statistics regarding to minimum and maximum temperatures, evaporation, weekly rainfall, relative humidity, wind velocity and bright sunshine hours during complete crop rises.

Experimental Approaches

The research was conducted in Augmented Randomized Complete Block Design (RBD) with 4 blocks. Pigeonpea germplasm were sown in single lines whereas four checks were replicated in all the blocks to calculate the error and get estimation of blocking effects. The trial seed was sown in 4 blocks and each block included of 25 genotypes and four checks. Spacing of 60 cm between rows and 20 cm between plants were kept. Dose of fertilizer are applied with rate of 20N: 50P: 20K kg/ha. Within the block checks were randomized. For normal growth thinning and gap filling were done that's also maintain plant population in uniform. The regular agronomic performs were implemented for normal crop cultivation.

Observations recorded

During study observations of several agro-morphological and qualitative characters were noted to fulfill the purposes of the study. Random 5 plants from each of pigeonpea genotypes row were observed for remarking data of various characters at guided plant growth stage from guidance of UPOV DUS guidance. Data were from the sampled plants are estimated mean value to different traits were practise to various statistical analyses.

Experimental material

The plant material total of 100 germplasm of Pigeonpea

collected from different parts of Chhattisgarh and 4 checks were used in present study.

Table 1: List of germplasm accessions of Pigeonpea and standard checks used in the present study

Entry No.	Genotype	Entry No.	Genotype	Entry No.	Genotype
CH1	CGA2	T32	RP-161	T67	RP-197
CH2	CGA1	T33	RP-162	T68	RP-198
CH3	RJLN	T34	RP-163	T69	RP-199
CH4	ASHA	T35	RP-164	T70	RP-200
T1	RP-124	T36	RP-165	T71	ICP-6993
T2	RP-126	T37	RP-166	T72	ICP-6994
T3	RP-127	T38	RP-167	T73	ICP-6995
T4	RP-128	T39	RP-169	T74	ICP-6996
T5	RP-129	T40	RP-170	T75	ICP-6997
T6	RP-130	T41	RP-171	T76	ICP-6998
T7	RP-131	T42	RP-172	T77	ICP-7000
T8	RP-132	T43	RP-173	T78	ICP-7001
T9	RP-133	T44	RP-174	T79	ICP-7002
T10	RP-134	T45	RP-175	T80	ICP-7003
T11	RP-135	T46	RP-176	T81	ICP-7004
T12	RP-136	T47	RP-177	T82	ICP-7005
T13	RP-137	T48	RP-178	T83	ICP-7349
T14	RP-138	T49	RP-179	T84	ICP-7358
T15	RP-139	T50	RP-180	T85	ICP-7359
T16	RP-140	T51	RP-181	T86	ICP-7362
T17	RP-141	T52	RP-182	T87	ICP-7363
T18	RP-142	T53	RP-183	T88	ICP-7364
T19	RP-143	T54	RP-184	T89	ICP-7366
T20	RP-144	T55	RP-185	T90	ICP-7367
T21	RP-145	T56	RP-186	T91	ICP-7373
T22	RP-146	T57	RP-187	T92	ICP-7376
T23	RP-149	T58	RP-188	T93	ICP-7379
T24	RP-150	T59	RP-189	T94	ICP-7382
T25	RP-152	T60	RP-190	T95	ICP-7384
T26	RP-155	T61	RP-191	T96	ICP-7389
T27	RP-156	T62	RP-192	T97	ICP-7391
T28	RP-157	T63	RP-193	T98	ICP-7392
T29	RP-158	T64	RP-194	T99	ICP-7393
T30	RP-159	T65	RP-195	T100	ICP-7397
T31	RP-160	T66	RP-196		

Note: CH=check variety, T=new treatment entry.

Results

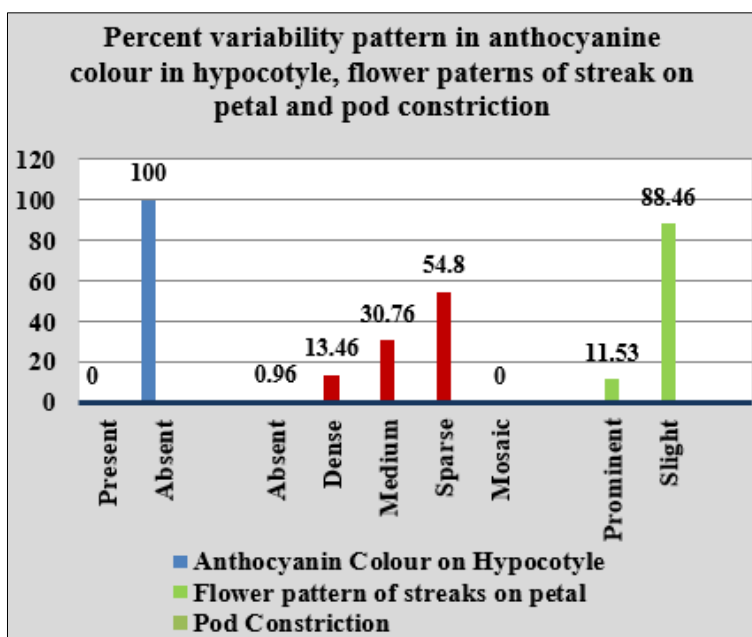
The data of preliminary characterization of 104 accessions of pigeonpea germplasm were recorded for 15 agro-morphological characters revealed a wide range of variability in qualitative characters. The range of variability and frequency observed in qualitative characters are given in Table 1. Out of 104 germplasm, in anthocyanin colour on hypocotyls trait (0) germplasm shows present and all (104) germplasm were absent. The plant branching pattern (15) germplasm are erect, (74) germplasm are Semi-spreading and (15) genotypes are spreading were recorded at visual assessment of total (104) germplasm. Plant growth habit trait divided into two categories determinant and in determinants, out of (104) germplasm (74) Determinate and (30) are in determinants were recorded. Stem colour classification were (90) are green and (14) are purple were recorded on the basis of visual assessment from the total (104) genotypes. Leaf shape group (82) are oblong and (22) are narrowly oblong were recorded from entire (104) genotypes of plants. The trait of pubescence on lower surface of the leaf were recorded (0) germplasms present and (104) absent from (104) genotypes. The visual assessment trait Flower colour of base on petal was

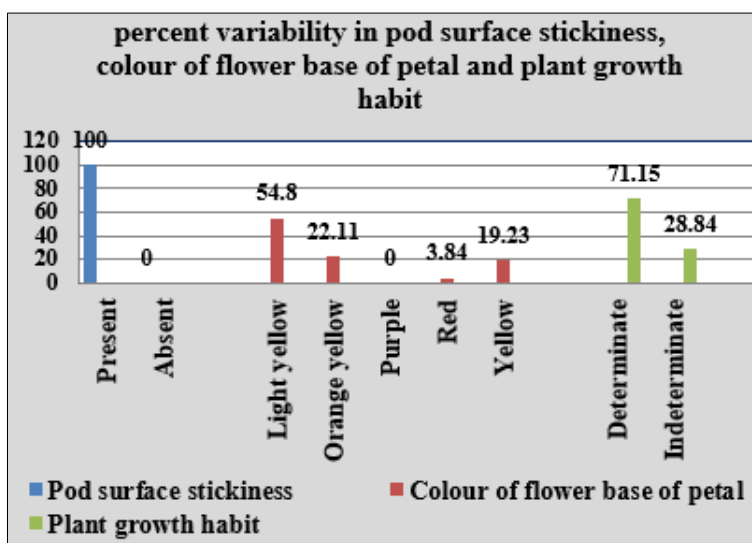
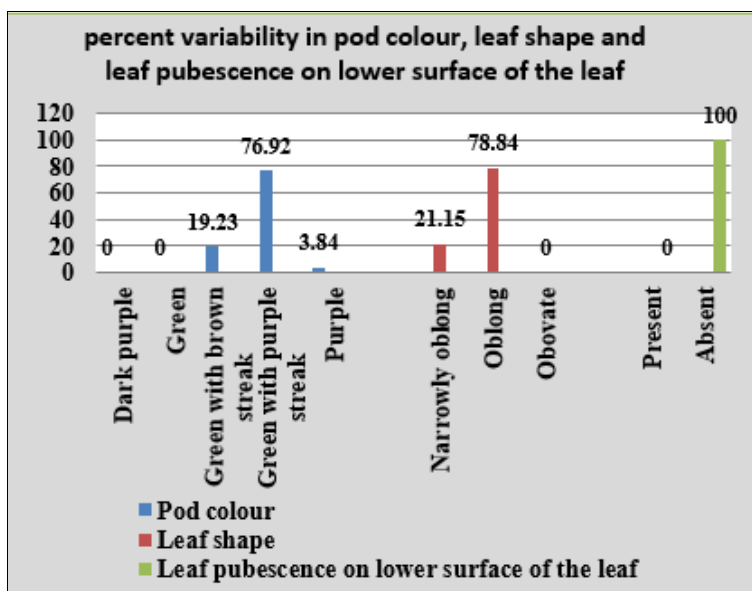
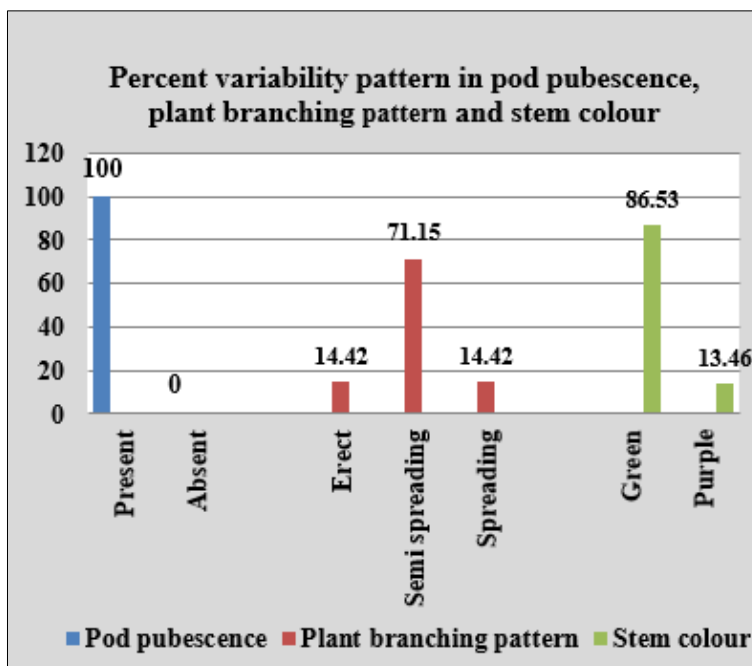
recorded at group of light yellow (57), orange yellow (23), red (4) and yellow (20) genotypes out of (104) germplasms. Flower pattern of streak on petals 1 are absent, (57) sparse, (32) medium, (14) dense from (104) total germplasms. The trait of Pod colour noted at (20) green with brown streak, (80) green with purple streak and (4) purple genotypes out of (104) genotypes. The trait of pod pubescence were recorded out of total (104) genotypes, (104) presence and (0) absence based on the hairy like structure present on fully developed green pods. The (104) presence and (0) absence genotypes of pod waxiness were recorded at out of (104) total plant genotype. During experiment (92) slight and (12) prominent type of genotypes of pod constriction was recorded from the entire

(104) genotypes of plants. Pod surface stickiness are divided into presence or absence of stickiness on pod surface, (104) germplasm were presence and (0) absence genotypes were recorded out of the total (104) genotypes. The Seed colour was recorded at ripe seed stage through visual assessment of individual plants that grouped into classes 46 are brown, (39) are dark brown, (6) are grey and (3) genotypes are purple. In seed colour pattern (99) are uniform and (5) genotypes are mottled were recorded on the basis of visual assessment. In seed shape (94) genotypes are oval, (43) are globular and (10) genotypes are elongated out of (104) germplasm, Followed by seed colour pattern, seed colour, seed eye colour, seed shape and seed size as described in Loko *et al.* (2018)^[7].

Table 2: Fractional assessment and dispersal occurrence of agro-morphological characters on four checks with 100 local landraces of Pigeonpea

S. No.	Trait s	Categories	Freq. No.	Freq. Percentages
1	Anthocyanin colour on hypocotyls	Present	0	0.00
		Absent	104	100.00
2	Flower pattern of streaks on petal	Absent	1	0.96
		Dense	14	13.46
		Medium	32	30.76
		Sparse	57	54.80
		Mosaic	0	0.00
3	Pod constriction	Prominent	12	11.53
		Slight	92	88.46
4	Pod pubescence	Present	104	100.00
		Absent	0	0.00
5	Plant branching pattern	Erect	15	14.42
		Semi spreading	74	71.15
		Spreading	15	14.42
6	Stem colour	Green	90	86.53
		Purple	14	13.46
7	Pod colour	Dark purple	0	0.00
		Green	0	0.00
		Green with brown streak	20	19.23
		Green with purple streak	80	76.92
		Purple	4	3.84
8	Leaf shape	Narrowly oblong	22	21.15
		Oblong	82	78.84
		Obovate	0	0.00
9	Leaf pubescence on lower surface of the leaf	Present	0	0.00





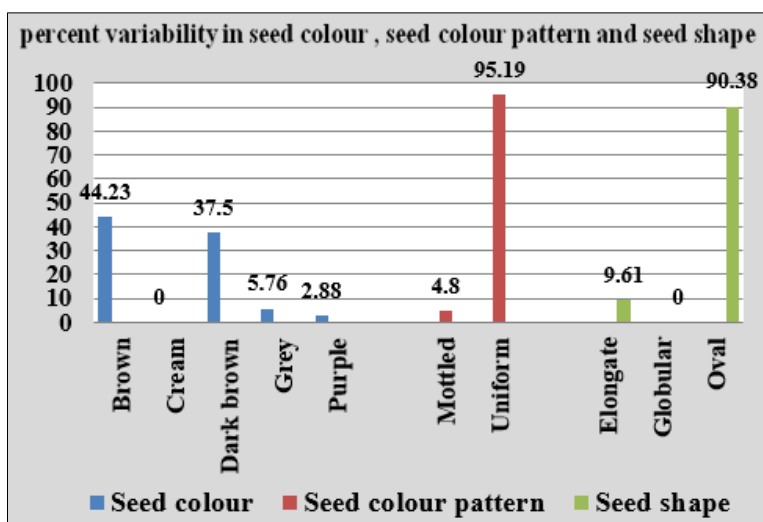
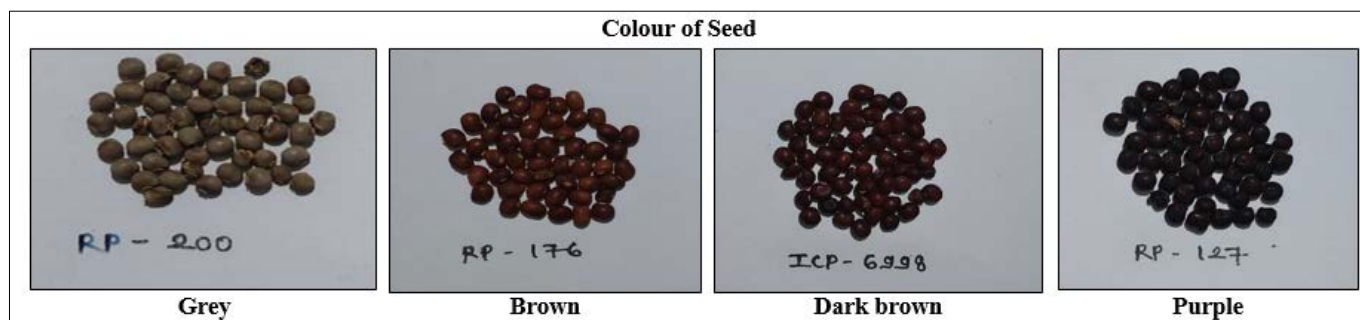
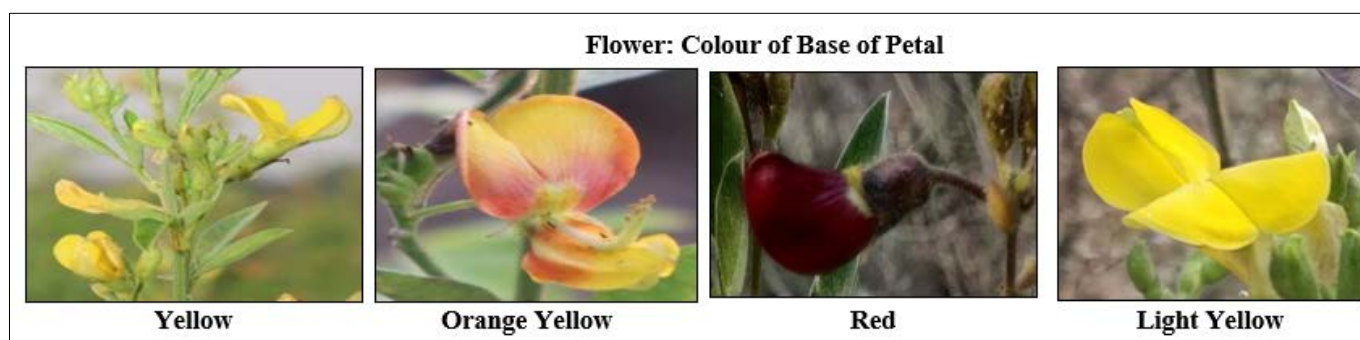
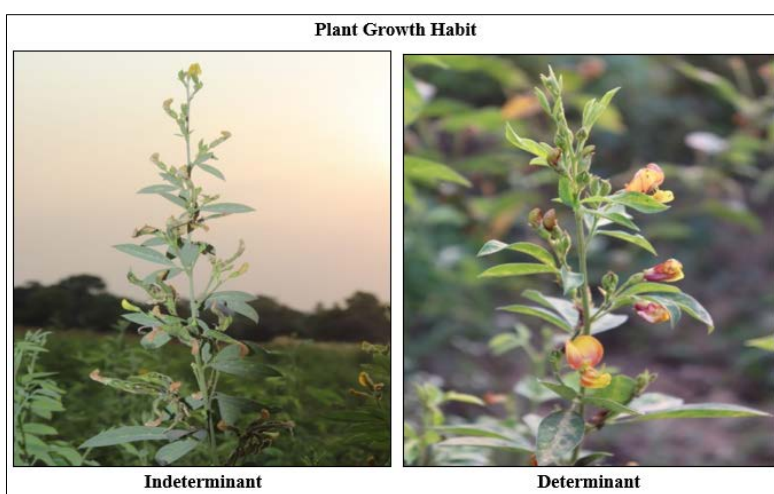
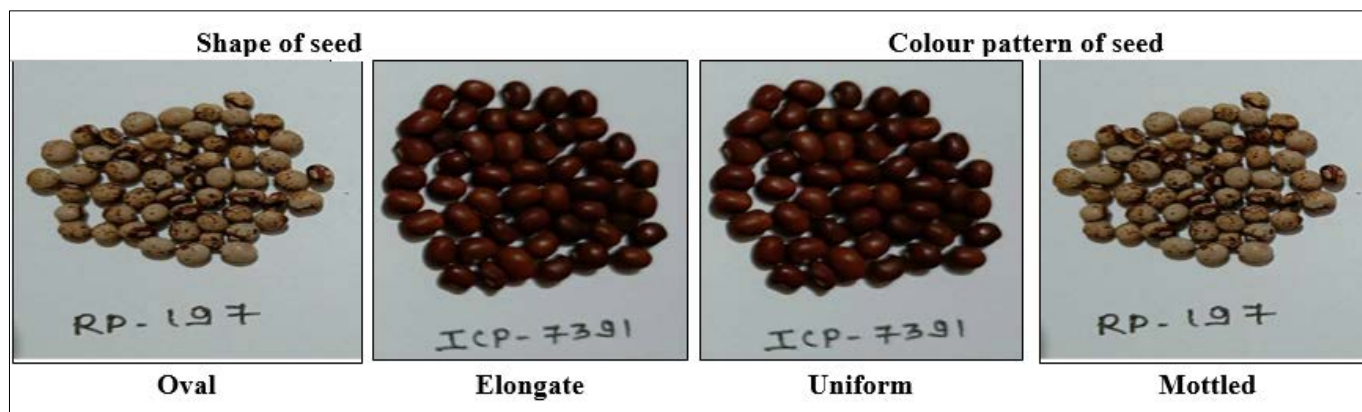
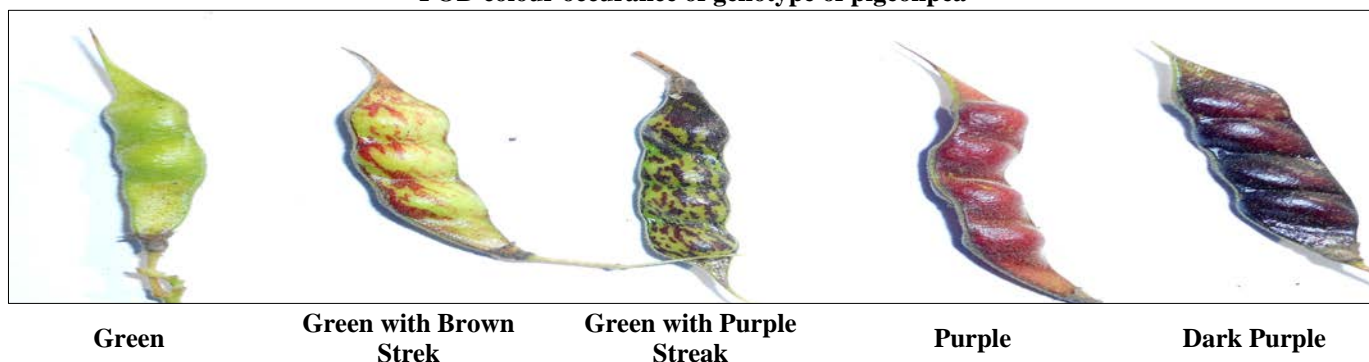


Fig 1: Percent (%) variability pattern in qualitative traits for 104 genotypes of pigeonpea.





POD colour occurrence of genotype of pigeonpea



Flower Pattern on Streaks of Petal



Fig 2: Images of variation present in 104 accessions of pigeonpea for morphological traits

Table 3: Classification of pigeonpea genotypes based on morphological traits.

Trait	Anthocyanin colour on hypocotyle	Genotypes
	Absent (100)	CGA2, CGA1, RJLN, ASHA, RP-124, RP-126, RP-127, RP-128, RP-129, RP-130, RP-131, RP-132, RP-133, RP-134, RP-135, RP-136, RP-137, RP-138, RP-139, RP-140, RP-141, RP-142, RP-143, RP-144, RP-145, RP-146, RP-149, RP-150, RP-152, RP-155, RP-156, RP-157, RP-158, RP-159, RP-160, RP-161, RP-162, RP-163, RP-164, RP-165, RP-166, RP-167, RP-169, RP-170, RP-171, RP-172, RP-173, RP-174, RP-175, RP-176, RP-177, RP-178, RP-179, RP-180, RP-181, RP-182, RP-183, RP-184, RP-185, RP-186, RP-187, RP-188, RP-189, RP-190, RP-191, RP-192, RP-193, RP-194, RP-195, RP-196, RP-197, RP-198, RP-199, RP-200, ICP-6993, ICP-6994, ICP-6995, ICP-6996, ICP-6997, ICP-6998, ICP-7000, ICP-7001, ICP-7002, ICP-7003, ICP-7004, ICP-7005, ICP-7349, ICP-7358, ICP-7359, ICP-7362, ICP-7363, ICP-7364, ICP-7366, ICP-7367, ICP-7373, ICP-7376, ICP-7379, ICP-7382, ICP-7384, ICP-7389, ICP-7391, ICP-7392, ICP-7393, ICP-7397
Categories	Present (0)	
Trait	Pod pubescence	Genotypes
	Present (100)	CGA2, CGA1, RJLN, ASHA, RP-124, RP-126, RP-127, RP-128, RP-129, RP-130, RP-131, RP-132, RP-133, RP-134, RP-135, RP-136, RP-137, RP-138, RP-139, RP-140, RP-141, RP-142, RP-143, RP-144, RP-145, RP-146, RP-149, RP-150, RP-152, RP-155, RP-156, RP-157, RP-158, RP-159, RP-160, RP-161, RP-162, RP-163, RP-164, RP-165, RP-166, RP-167, RP-168, RP-169, RP-170, RP-171, RP-172, RP-173, RP-174, RP-175, RP-176, RP-177, RP-178, RP-179, RP-180, RP-181, RP-182, RP-183, RP-184, RP-185, RP-186, RP-187, RP-188, RP-189, RP-190, RP-191, RP-192, RP-193, RP-194, RP-195, RP-196, RP-197, RP-198, RP-199, RP-200, ICP-6993, ICP-6994, ICP-6995, ICP-6996, ICP-6997, ICP-6998, ICP-7000, ICP-7001, ICP-7002, ICP-7003, ICP-

		7004, ICP-7005, ICP-7349, ICP-7358, ICP-7359, ICP-7362, ICP-7363, ICP-7364, ICP-7366, ICP-7367, ICP-7373, ICP-7376, ICP-7379, ICP-7382, ICP-7384, ICP-7389, ICP-7391, ICP-7392
Categories	Absent (0)	
Trait	Flower pattern of streaks on petal	Genotypes
	Absent (1)	RP-193
	Dense (14)	RP-140, RP-160, RP-161, RP-171, RP-181, RP-182, RP-188, ICP-7001, ICP-7002, ICP-7364, ICP-7367, ICP-7373, ICP-7393, ICP-7397
Categories	Medium (32)	CGA2, CGA1, RP-124, RP-127, RP-126, RP-128, RP-129, RP-131, RP-132, RP-133, RP-134, RP-135, RP-139, RP-156, RP-157, RP-167, RP-170, RP-172, RP-173, RP-179, RP-180, RP-184, RP-185, RP-186, RP-187, RP-198, RP-199, ICP-6996, ICP-7003, ICP-7384, ICP-7389, ICP-7391
	Sparse (57)	RJLN, ASHA, RP-130, RP-136, RP-137, RP-138, RP-141, RP-142, RP-143, RP-144, RP-145, RP-146, RP-149, RP-150, RP-152, RP-155, RP-158, RP-159, RP-162, RP-163, RP-164, RP-165, RP-166, RP-169, RP-174, RP-175, RP-176, RP-177, RP-178, RP-183, RP-189, RP-190, RP-191, RP-192, RP-194, RP-195, RP-196, RP-197, RP-198, RP-199, RP-200, ICP-6993, ICP-6994, ICP-6995, ICP-6997, ICP-6998, ICP-7000, ICP-7004, ICP-7005, ICP-7349, ICP-7358, ICP-7359, ICP-7362, ICP-7363, ICP-7366, ICP-7376, ICP-7379, ICP-7382, ICP-7392
	Mosaic ()	
Trait	Stem colour	Genotypes
	Green (90)	CGA2, CGA1, RJLN, ASHA, RP-124, RP-126, RP-127, RP-128, RP-129, RP-130, RP-131, RP-132, RP-133, RP-134, RP-136, RP-138, RP-139, RP-140, RP-141, RP-143, RP-144, RP-146, RP-149, RP-150, RP-157, RP-158, RP-159, RP-160, RP-161, RP-162, RP-163, RP-164, RP-165, RP-166, RP-167, RP-169, RP-170, RP-171, RP-172, RP-174, RP-175, RP-176, RP-178, RP-179, RP-180, RP-184, RP-187, RP-188, RP-189, RP-190, RP-191, RP-192, RP-193, RP-194, RP-195, RP-196, RP-197, RP-198, RP-199, RP-200, ICP-6993, ICP-6994, ICP-6995, ICP-6996, ICP-6997, ICP-6998, ICP-7000, ICP-7001, ICP-7002, ICP-7003, ICP-7004, ICP-7005, ICP-7349, ICP-7358, ICP-7359, ICP-7362, ICP-7363, ICP-7364, ICP-7366, ICP-7367, ICP-7373, ICP-7376, ICP-7379, ICP-7382, ICP-7384, ICP-7389, ICP-7391, ICP-7392, ICP-7393, ICP-7397
Categories	Purple (14)	RP-135, RP-137, RP-142, RP-145, RP-152, RP-155, RP-156, RP-173, RP-177, RP-181, RP-182, RP-183, RP-185, RP-186
Trait	Pod constriction	Genotypes
	Prominent (12)	RP-192, RP-193, RP-195, ICP-6996, ICP-7001, ICP-7003, ICP-7004, ICP-7358, ICP-7362, ICP-7367, ICP-7379, ICP-7392
Categories		CGA2, CGA1, RJLN, ASHA, RP-124, RP-126, RP-127, RP-128, RP-129, RP-130, RP-131, RP-132, RP-133, RP-134, RP-135, RP-136, RP-137, RP-138, RP-139, RP-140, RP-141, RP-142, RP-143, RP-144, RP-145, RP-146, RP-149, RP-150, RP-152, RP-155, RP-156, RP-157, RP-158, RP-159, RP-160, RP-161, RP-162, RP-163, RP-164, RP-165, RP-166, RP-167, RP-168, RP-169, RP-170, RP-171, RP-172, RP-173, RP-174, RP-175, RP-176, RP-177, RP-178, RP-179, RP-180, RP-181, RP-182, RP-183, RP-184, RP-185, RP-186, RP-187, RP-188, RP-189, RP-190, RP-191, RP-194, RP-196, RP-197, RP-198, RP-199, RP-200, ICP-6993, ICP-6994, ICP-6995, ICP-6997, ICP-6998, ICP-7000, ICP-7002, ICP-7005, ICP-7349, ICP-7359, ICP-736, ICP-7364, ICP-7366, ICP-7373, ICP-7376, ICP-7382, ICP-7384, ICP-7389, ICP-7391, ICP-7393
Trait	Pod colour	Genotypes
	Dark purple (0)	
Categories	Green (0)	
	Green with brown streak (20)	RP-140, RP-145, RP-163, RP-170, RP-179, RP-180, RP-182, RP-186, RP-188, RP-190, RP-196, RP-197, ICP-6994, ICP-7004, ICP-7005, ICP-7349, ICP-7362, ICP-7367, ICP-7392, ICP-7397
	Green with purple streak (80)	CGA2, CGA1, RJLN, ASHA, RP-124, RP-126, RP-127, RP-128, RP-129, RP-130, RP-131, RP-132, RP-133, RP-135, RP-136, RP-137, RP-138, RP-139, RP-141, RP-142, RP-143, RP-144, RP-146, RP-149, RP-150, RP-152, RP-155, RP-156, RP-157, RP-158, RP-159, RP-160, RP-161, RP-162, RP-164, RP-165, RP-166, RP-167, RP-169, RP-172, RP-173, RP-174, RP-175, RP-176, RP-177, RP-178, RP-183, RP-184, RP-185, RP-187, RP-189, RP-191, RP-192, RP-193, RP-195, RP-198, RP-199, RP-200 ICP-6993 ICP-6995, ICP-6996, ICP-6997, ICP-6998, ICP-7000, ICP-7001, ICP-7002, ICP-7003, ICP-7358, ICP-7359, ICP-7363, ICP-7364, ICP-7366 ICP-7373, ICP-7376, ICP-7379, ICP-7382, ICP-7384 ICP-7389 ICP-7391 ICP-7393, ICP-7398, ICP-7405
	Purple (4)	RP-134, RP-171, RP-181, RP-194, ICP-7404, ICP-7406
Trait	Leaf pubescence on lower surface of the leaf	Genotypes
	Present (0)	
Categories	Absent (100)	CGA2, CGA1, RJLN, ASHA, RP-124, RP-126, RP-127, RP-128, RP-129, RP-130, RP-131, RP-132, RP-133, RP-134, RP-135, RP-136, RP-137, RP-138, RP-139, RP-140, RP-141, RP-142, RP-143, RP-144, RP-145, RP-146, RP-149, RP-150, RP-152, RP-155, RP-156, RP-157, RP-158, RP-159, RP-160, RP-161, RP-162, RP-163, RP-164, RP-165, RP-166, RP-167, RP-169, RP-170, RP-171, RP-172, RP-173, RP-174, RP-175, RP-176, RP-177, RP-178, RP-179, RP-180, RP-181, RP-182, RP-183, RP-184, RP-185, RP-186, RP-187, RP-188, RP-189, RP-190, RP-191, RP-192, RP-193, RP-194, RP-195, RP-196, RP-197, RP-198, RP-199, RP-200, ICP-6993, ICP-6994, ICP-6995, ICP-6996, ICP-6997, ICP-6998, ICP-7000, ICP-7001, ICP-7002, ICP-7003, ICP-7004, ICP-7005, ICP-7349, ICP-7358, ICP-7359, ICP-7362, ICP-7363, ICP-7364, ICP-7366, ICP-7367, ICP-7373, ICP-7376, ICP-7379, ICP-7382, ICP-7384, ICP-7389, ICP-7391, ICP-7392, ICP-7393, ICP-7397
Trait	Pod surface stickiness	Genotypes
Categories	Present (104)	CGA2, CGA1, RJLN, ASHA, RP-124, RP-126, RP-127, RP-128, RP-129, RP-130, RP-131, RP-132, RP-133, RP-134, RP-135, RP-136, RP-137, RP-138, RP-139, RP-140, RP-141, RP-142, RP-143, RP-144, RP-145, RP-

		146, RP-149, RP-150, RP-152, RP-155, RP-156, RP-157, RP-158, RP-159, RP-160, RP-161, RP-162, RP-163, RP-164, RP-165, RP-166, RP-167, RP-169, RP-170, RP-171, RP-172, RP-173, RP-174, RP-175, RP-176, RP-177, RP-178, RP-179, RP-180, RP-181, RP-182, RP-183, RP-184, RP-185, RP-186, RP-187, RP-188, RP-189, RP-190, RP-191, RP-192, RP-193, RP-194, RP-195, RP-196, RP-197, RP-198, RP-199, RP-200, ICP-6993, ICP-6994, ICP-6995, ICP-6996, ICP-6997, ICP-6998, ICP-6998, ICP-7000, ICP-7001, ICP-7002, ICP-7003, ICP-7004, ICP-7005, ICP-7349, ICP-7358, ICP-7359, ICP-7362, ICP-7363, ICP-7364, ICP-7366, ICP-7367, ICP-7373, ICP-7376, ICP-7379, ICP-7382, ICP-7384, ICP-7389, ICP-7391, ICP-7392, ICP-7393, ICP-7397
	Absent (0)	
Trait	Seed shape	Genotypes
Categories	Elongate (10)	RP-130, RP-144, RP-161, RP-166, RP-183 RP-186, ICP-7004, ICP-7393, ICP-7384, ICP-7391
	Globular (0)	
	Oval (94)	CGA2, CGA1, RJLN, ASHA, RP-124, RP-126, RP-127, RP-128, RP-129, RP-131, RP-132, RP-133, RP-134, RP-135, RP-136, RP-137, RP-138, RP-139, RP-140, RP-141, RP-142, RP-143, RP-145, RP-146, RP-149, RP-150, RP-152, RP-155, RP-156, RP-157, RP-158, RP-159, RP-160, RP-162, RP-163, RP-164, RP-165, RP-166, RP-167, RP-169, RP-170, RP-171, RP-172, RP-173, RP-174, RP-175, RP-176, RP-177, RP-178, RP-179, RP-180, RP-181, RP-182, RP-184, RP-185, RP-188, RP-189, RP-190, RP-191, RP-192, RP-193, RP-194, RP-195, RP-196, RP-197, RP-198, RP-199, RP-200, ICP-6993, ICP-6994, ICP-6995, ICP-6996, ICP-6997, ICP-6998, ICP-7000, ICP-7001, ICP-7002, ICP-7003, ICP-7005, ICP-7349, ICP-7358, ICP-7359, ICP-7362, ICP-7363, ICP-7364, ICP-7366, ICP-7367, ICP-7373, ICP-7376, ICP-7379, ICP-7382, ICP-7384, ICP-7389, ICP-7391, ICP-7392, ICP-7397
Trait	Colour of flower base of petal	Genotypes
Categories	Light yellow (57)	CGA1, RP-126, RP-127, RP-131, RP-133, RP-134, RP-136, RP-137, RP-138 RP-141, RP-142, RP-146, RP-149, RP-150, RP-152, RP-155, RP-156, RP-163, RP-164, RP-169, RP-170, RP-171, RP-172, RP-176, RP-177, RP-178, RP-179, RP-180, RP-181, RP-182, RP-183, RP-184, RP-185, RP-187, RP-190, RP-191, RP-192, RP-193, RP-194, RP-197, RP-198, ICP-6993, ICP-6994, ICP-6995, ICP-6996, ICP-6997, ICP-7004, ICP-7005, ICP-7349, ICP-7358, ICP-7359, ICP-7362, ICP-7376, ICP-7379, ICP-7382, ICP-7384, ICP-7392
	Orange yellow (23)	CGA2, RP-128, RP-130, RP-135 RP-140, RP-143, RP-144, RP-157, RP-160, RP-161, RP-166, RP-167, RP-175, RP-186, RP-188, RP-189, ICP-6998, ICP-7000, ICP-7001, ICP-7366, ICP-7367, ICP-7393, ICP-7397
	Purple (0)	
	Red (4)	RP-124, RP-145, ICP-7389, ICP-7391
	Yellow (20)	RJLN, ASHA, RP-129, RP-132, RP-139, RP-158, RP-159, RP-162 RP-165, RP-173, RP-174, RP-195, RP-196, RP-199, RP-200, ICP-7002, ICP-7003, ICP-7363, ICP-7364, ICP-7373
Trait	Plant growth habit	Genotypes
Categories	Determinate (70)	RJLN, RP-126, RP-127, RP-128, RP-129, RP-130, RP-131, RP-132, RP-133, RP-135, RP-136, RP-137, RP-138, RP-139, RP-141, RP-142, RP-144, RP-145, RP-149, RP-150 RP-152, RP-156, RP-157, RP-159, RP-163 RP-164, RP-166, RP-167, RP-169, RP-170, RP-171, RP-173, RP-174, RP-175, RP-176, RP-177, RP-178, RP-180, RP-181, RP-183, RP-184, RP-186, RP-187, RP-188, RP-189, RP-190, RP-191, RP-192, RP-193, RP-194, RP-197, RP-199, RP-200, ICP-6995, ICP-6996, ICP-6997, ICP-7000, ICP-7001, ICP-7002, ICP-7003, ICP-7004, ICP-7005, ICP-7349, ICP-7358, ICP-7359, ICP-7362, ICP-736, ICP-7366, ICP-7367, ICP-7379, ICP-7384, ICP-7392, ICP-7393, ICP-7397
	Indeterminate (34)	CGA2, CGA1, ASHA, RP-124, RP-134, RP-140, RP-143, RP-146, RP-155, RP-158, RP-160, RP-161, RP-162, RP-165, RP-172, RP-179, RP-182, RP-185, RP-195, RP-196, RP-198, ICP-6993, ICP-6994, ICP-6998, ICP-7364, ICP-7373, ICP-7376, ICP-7382, ICP-7389, ICP-7391
Trait	Seed colour pattern	Genotypes
Categories	Mottled	ICP-7389, RP-171, CGA1, ASHA, RP-124
	Uniform	RP-129, RP-130, RP-131, RP-132, RP-135, RP-136, RP-140, RP-141, RP-142, RP-143, RP-146, RP-150, RP-155, RP-156, RP-157, RP-161, RP-163, RP-167, RP-169, RP-170, RP-173, RP-174, RP-175, RP-179, RP-181, RP-182, RP-183, RP-184, RP-185, RP-188, RP-190, RP-191, RP-192, RP-194, RP-195, RP-200, ICP-6993, ICP-6997, ICP-7000, ICP-7001, ICP-7002, ICP-7003, ICP-7358, ICP-7373, ICP-7379, ICP-7392, ICP-7397, CGA2, RJLN, RP-126, RP-128, RP-133, RP-134, RP-137, RP-138, RP-139, RP-144, RP-149, RP-152, RP-158, RP-159, RP-160, RP-162, RP-164, RP-165, RP-172, RP-176, RP-178, RP-180, RP-186, RP-187, RP-193, ICP-6994, ICP-6995, ICP-6996, ICP-6998, ICP-7004, ICP-7005, ICP-7349, ICP-7359, ICP-7362, ICP-7363, ICP-7364, ICP-7366, ICP-7367, ICP-7376, ICP-7382, RP-177, RP-189, RP-196, RP-197, RP-198, RP-199, RP-127, RP-145, ICP-7393, RP-166, ICP-7384, ICP-7391
Trait	Plant branching pattern	Genotypes
Categories	Erect	RP-130, RP-140, RP-145, RP-152, RP-170, RP-173, RP-174, RP-185, RP-199, ICP-6995, ICP-7004, ICP-7362, ICP-7397
	Semi spreading	CGA2, CGA1, RJLN, RP-124, RP-126, RP-127, RP-128, RP-133, RP-134, RP-135, RP-136, RP-137, RP-138, RP-139, RP-141, RP-142, RP-144, RP-149, RP-150, RP-155, RP-156, RP-157, RP-158, RP-161, RP-162, RP-163, RP-164, RP-166, RP-168, RP-172, RP-175, RP-176, RP-179, RP-180, RP-181, RP-182, RP-183, RP-184, RP-186, RP-187, RP-188, RP-189, RP-190, RP-191, RP-193, RP-194, RP-195, RP-196, RP-197, RP-200, ICP-6993, ICP-6994, ICP-6996, ICP-6997, ICP-6998, ICP-7000, ICP-7005, ICP-7349, ICP-7358, ICP-7359, ICP-7363, ICP-7364, ICP-7367, ICP-7373, ICP-7376, ICP-7379, ICP-7382, ICP-7384, ICP-7389, ICP-7391, ICP-7392, ICP-7393
	Spreading	ASHA, RP-129, RP-131, RP-132, RP-143, RP-146, RP-159, RP-160, RP-165, RP-167, RP-169, RP-171, RP-177, RP-178, RP-192, RP-198, ICP-7001, ICP-7002, ICP-7003, ICP-7366

Trait	Leaf shape	Genotypes
Categories	Narrowly oblong	CGA1, RP-126, RP-135, RP-142, RP-143, RP-149, RP-155, RP-161, RP-163, RP-170, RP-171, RP-174, RP-181, RP-182, RP-184, RP-186, RP-189, ICP-7358, ICP-7389, ICP-7392, ICP-7393, ICP-7397
	Oblong	CGA2, RJLN, ASHA RP-124, RP-127, RP-128, RP-129, RP-130, RP-131, RP-132, RP-133, RP-134, RP-136, RP-137, RP-138, RP-139, RP-140, RP-141, RP-144, RP-145, RP-146, RP-150, RP-152, RP-156, RP-157, RP-158, RP-159, RP-160, RP-162, RP-164, RP-165, RP-166, RP-167, RP-169, RP-172, RP-173, RP-175, RP-176, RP-177, RP-178, RP-179, RP-180, RP-183, RP-183, RP-185, RP-187, RP-188, RP-190, RP-191, RP-192, RP-193, RP-194, RP-195, RP-196, RP-197, RP-198, RP-199, RP-200, ICP-6993, ICP-6994, ICP-6995, ICP-6996, ICP-6997, ICP-6998, ICP-7000, ICP-7001, ICP-7002, ICP-7003, ICP-7004, ICP-7005, ICP-7349, ICP-7359, ICP-7362, ICP-7363, ICP-7364, ICP-7366, ICP-7367, ICP-7373, ICP-7376, ICP-7379, ICP-7382, ICP-7384, ICP-7391
	Obovate (0)	
Trait	Seed colour	Genotypes
Categories	Brown (56)	ICP-7389, RP-171, CGA1, ASHA, RP-124, RP-129, RP-130, RP-131, RP-132, RP-135, RP-136, RP-140, RP-141, RP-142, RP-143, RP-146, RP-150, RP-155, RP-156, RP-157 RP-161, RP-163, RP-167, RP-169, RP-170, RP-173, RP-174, RP-175, RP-179, RP-181, RP-182, RP-183, RP-184, RP-185, RP-188, RP-190, RP-191, RP-192, RP-194, RP-195, RP-200, ICP-6993, ICP-6997, ICP-7000, ICP-7001, ICP-7002, ICP-7003, ICP-7358, ICP-7373, ICP-7379, ICP-7392, ICP-7397, CGA2, RP-166, ICP-7384, ICP-7391
	Cream (0)	
	Dark brown (39)	RJLN, RP-126, RP-128, RP-133, RP-134, RP-137, RP-138, RP-139, RP-144, RP-149, RP-152, RP-158, RP-159, RP-160, RP-162, RP-164, RP-165, RP-172, RP-176, RP-178, RP-180, RP-186, RP-187, RP-193, ICP-6994, ICP-6995, ICP-6996, ICP-6998, ICP-7004, ICP-7005, ICP-7349, ICP-7359, ICP-7362, ICP-7363, ICP-7364, ICP-7366, ICP-7367, ICP-7376, ICP-7382
	Grey (6)	RJLN, RP-126, RP-128, RP-133, RP-134, RP-137, RP-138, RP-139, RP-144, RP-149, RP-152, RP-158, RP-159, RP-160, RP-162, RP-164, RP-165, RP-172, RP-176, RP-178, RP-180, RP-186, RP-187, RP-193, ICP-6994, ICP-6995, ICP-6996, ICP-6998, ICP-7004, ICP-7005, ICP-7349, ICP-7359, ICP-7362, ICP-7363, ICP-7364, ICP-7366, ICP-7367, ICP-7376, ICP-7382
	Purple (3)	RJLN, RP-126, RP-128, RP-133, RP-134, RP-137, RP-138, RP-139, RP-144 RP-149, RP-152, RP-158, RP-159, RP-160, RP-162, RP-164, RP-165, RP-172, RP-176, RP-178, RP-180, RP-186, RP-187, RP-193, ICP-6994, ICP-6995, ICP-6996, ICP-6998, ICP-7004, ICP-7005, ICP-7349, ICP-7359, ICP-7362, ICP-7363, ICP-7364, ICP-7366, ICP-7367, ICP-7376, ICP-7382

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