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## Qualitative characterization of diverse germplasm of soybean (*Glycine max* (L.) Merrill)

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### Abstract

The present investigation was conducted with 294 genotypes along with 4 checks viz., JS 20-34, JS 95-60, NRC 86 and NRC 37 at N.E. Borlaug Crop Research Centre, G. B. Pant University of Agriculture and Technology, Pantnagar, during *Kharif*, 2016 and 2017. The experimental material was planted in an augmented design-II with 6 blocks, each consisting of 49 test entries and 4 checks planted randomly and in which only checks were repeated in each block. The objectives of the present study were characterization of genotypes based on qualitative characters. A total of 11 qualitative characters were taken up for the present study. The result revealed that morphological characters contributed toward genotype divergence in soybean. The results obtained from the present study indicated a possibility of pubescence colour and pod colour showing linked inheritance and the characters flower colour and hypocotyl colour also showing linked inheritance. It was also found that characters pod colour and hilum colour contributed more toward divergence than the other qualitative characters including the present study.

**Keywords:** Soybean, qualitative, characterization and augmented design

### Introduction

Soybean [*Glycine max* (L.) Merrill] is an important leguminous crop widely cultivated in tropical, sub-tropical and temperate regions of the world. Soybean (2n=40) belongs to order fabales and family *Fabaceae* and North-eastern China region is primary centre of origin of this crop. Soybean is an important multi-purpose leguminous crop known for its highly valued protein and oil, and its use in food, feed and industrial applications. Hence it is popularly known as the "Golden Bean" or "Miracle crop" of the 20<sup>th</sup> century. Apart from that, soybean also enriches the soil productivity by fixing atmospheric nitrogen in the soil at the rate of 65-100kg/hectare (Patil et al. 2014) [8] through symbiosis with bacterium *Rhizobium japonicum* and thus rejuvenates and maintains the soil fertility. Soybean has become a major source of protein for feed, edible vegetable oil and food supply in the world. It is also known for an excellent source of good quality unsaturated fatty acids (about 85%) and is extremely high in the essential fatty acids such as linoleic acid (53%), oleic acid (23%) and linolenic acid (7%). Low productivity in India is mainly due to the short growing period available in sub-tropical conditions, limited varietal stability and narrow genetic base of soybean cultivars (Singh and Hymowitz, 1999) [10]. For a plant breeder, a proper understanding and estimation of genetic variability is a pre-requisite. But the continuous exploitation of the variability has narrowed down the genetic base of the cultivated varieties to such an extent that it resulted in an augmentation in the losses due to biotic and abiotic stress factors thereby becoming a major concern for plant breeders. Hence, it is of utmost priority to regenerate the variability among the genotypes. Therefore, the knowledge of variability is desirable for a breeder before making any crop improvement program. The hybrids involving the parents with more diversity among them are expected to exhibit higher amount of heterotic expression and broad spectrum of variability in segregating generations. Genetic variability is useful parameters that can help the breeder during different stages of crop improvement. The success of breeding program will depend largely on the extent of genetic variability and heritability for important economic traits in early generation populations. Genetic variability is essential in any crop as it is the source of variation and also the raw material for yield enhancement. A highly reliable and

precise method for assessment of genetic variability devoid of environmental effects is essential to facilitate a valid estimate of parameters. In order to meet the growing needs of varietal improvement for higher productivity, it is essential to collect, evaluate and document the entire array of available genetic variability in germplasm.

### Material and Methods

The present study was conducted during *Kharif*, 2016 and 2017 season at N. E. Borlaug Crop Research Centre, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand, India. All the recommended cultural practices were adopted to raise a healthy crop. The experimental material of the investigation comprised of 294 genotypes along with 4 checks *viz.*, JS 20-34, JS 95-60, NRC 86 and NRC 37. The experiment was conducted in augmented design with six blocks. The details of experimental material used in experiment is given in Table 1. Considering each genotype as one treatment, the experiment was laid out in augmented design (Federer, 1956, 1961, and Federre & Raghavrao, 1975) <sup>[1-3]</sup> with six blocks. Each block planted with 49 genotypes including four checks. Each accession planted in a single row of 4 m length with the row to row distance 45 cm and plant to plant distance 5-7 cm. Standard package and practices were followed for raising a healthy crop.

### Characters studied and Observations procedure

All the 11 qualitative characters (Hypocotyl colour, Flower colour, Pubescence colour, Leaf shape, Leaf colour, Pubescence density, Seed coat colour, Hilum colour, Pod colour, Pod shattering character, Growth habit) of soybean plant was recorded or observed based on soybean descriptor (IBPGR, 1984) <sup>[5]</sup>. The hypocotyl pigmentation was observed at 10<sup>th</sup> day after sowing under natural daylight condition and it's classified into two different categories by visual assessment of pigmentation i.e. Green and Purple. On the basis of flower color, two classes were recorded among the genotypes i.e. White and Purple. Based on pubescence colour, genotypes were categorized into three categories i.e. Tawny (brown hair), Grey (white hair) and Light brown. Based on leaf shape all the accessions were divided into three categories i.e. Lanceolate, Pointed ovate and Round ovate. The fourth leaf from the top of the selected and tagged plant was used for the leaf colour at 50% flowering stage under natural daylight condition and the genotypes were classified as Light green, Yellowish green and Dark green. Based on pubescence density, genotypes were categorized into four categories: Sparse, Semi- sparse, Normal and Dense. Seed coat color showed wide range of variation in color and the given genotypes were classified into different colors such as yellowish-white, yellow, black, buff, reddish-brown, grey, green, and imperfect black. Hilum colour also shows considerable variability such as yellow, buff, brown, green, grey, imperfect black and black. The pod colour of soybean genotypes was observed under natural daylight condition at harvesting stage by visual assessment and classified as, Tan (Yellow colour), Brown colour and Black colour. Genotypes were grouped based on pod-shattering characteristic. This observation was taken at maturity. Genotypes were grouped as Shattering and Non- shattering. Based on plant growth habits all the accessions were classified into three categories

Determinate, Semi-determinate and Indeterminate.

### Results and Discussion

Characterization of genotypes is essential for its identification and avoiding duplication. Qualitative characters show stable inheritance over generation and hence are reliable for characterization of genotypes as they are less influenced by environment fluctuations. All the 298 genotypes (294 accessions + 4 checks) under study were classified into discrete groups under major categories representing 11 qualitative characters *viz.*, hypocotyl color, flower color, pubescence color, leaf shape, leaf color, pubescence density, seed coat color, hilum color, pod color, growth habit, and shattering character. Genotypes with accession number and their morphological qualitative characters are given in Table 2. In case of character hypocotyl colour, 236 genotypes had purple colour while 62 genotypes had green colour. In case of character flower colour, 238 genotypes had purple colour while 60 genotypes had white colour. In case of pubescence colour, 25 genotypes were gray, 271 were tawny, 2 were light brown. In case of character leaf shape, 207 were broad, 84 were intermediate while 7 were narrow. In case of leaf colour, 90 were dark green, 3 were yellowish Green and 205 were light green. In case of pubescence density 289 were dense and 9 were sparse. In case of seed coat colour, 145 genotypes were yellowish white, 71 genotypes were yellow, 9 genotypes were chocolate, 36 genotypes were green, 37 genotypes were black. In case of Hilum colour; 111 genotypes were yellow, 167 were black and 20 were brown. In case of pod colour, 110 genotypes were tan, 91 genotypes were black, 97 genotypes were brown. In case of pod shattering, 241 genotypes were non-shattering and 57 genotypes were shattering. In case of growth habit 219 genotypes were determinate, 53 genotypes semi-determinate, 26 were indeterminate. On the basis of result obtained it could be outlined that morphological characters play an important role and they do contribute toward genotype divergence in soybean. Contribution of these characters towards divergence may also be significant. Similar result was also reported by Gawande et al. (2001) <sup>[4]</sup>, Ramteke and Muralidharan (2012) <sup>[9]</sup> who characterized soybean accession on the basis of qualitative characters. Yadav and Sharma (2001) <sup>[11]</sup> reported large variation for hilum colour in soybean. The results obtained from the present study indicated a possibility of pubescence colour and pod colour showing linked inheritance and the characters flower colour and hypocotyl colour also showing linked inheritance. It was also found that characters pod colour and hilum colour contributed more toward divergence than the other qualitative characters including the present study. Morphological characters or markers, such as leaf size and shape, pubescence color, flower color, pod color, hilum color, seed shape, seed coat color, seed shape and plant height, etc. have been used traditionally to verify the genetics, association, varietal verification, seed production, maintenance and certification of genetic purity of a variety. Morphological markers are limited in number; their expression is often influenced by environment fluctuation, and many of them are not closely linked with economic traits and even have adverse effects on the development and growth of plants. However, morphological markers have been used for diversity analysis in various plant species (Khanande et al. 2016, Kachare et al. 2020) <sup>[7, 6]</sup>.

**Table 1:** List of soybean germplasm with accessions number

S. No.	Accession No.	S. No.	Accession No.	S. No.	Accession No.	S. No.	Accession No.	S. No.	Accession No.	S. No.	Accession No.	S. No.	Accession No.
1	AGS 129	44	CAT 1151	87	CAT 1258	130	CAT 1416	173	CAT 1541	216	CAT 1587	259	CAT 2008
2	AGS 142	45	CAT 1152	88	CAT 1258 B	131	CAT 1420	174	CAT 1543 B	217	CAT 1733	260	CAT 2024A
3	AGS 166	46	CAT 1158	89	CAT 1260	132	CAT 1425	175	CAT 1544	218	CAT 1734	261	CAT 2026
4	AGS 193	47	CAT 1164	90	CAT 1260 B	133	CAT 1426	176	CAT 1545	219	CAT 1735	262	CAT 2034B
5	AGS 205	48	CAT 1166	91	CAT 1266	134	CAT 1429	177	CAT 1548	220	CAT 1752	263	CAT 2039
6	AGS 373	49	CAT 1167 A	92	CAT 129	135	CAT 1430	178	CAT 1552 B	221	CAT 1757	264	CAT 204
7	BR 4	50	CAT 1167 B	93	CAT 1290	136	CAT 1431	179	CAT 156	222	CAT 1759 A	265	CAT 2041
8	CAT 1000	51	CAT 1168	94	CAT 1294	137	CAT 1432	180	CAT 1560	223	CAT 1760	266	CAT 2047
9	CAT 1002	52	CAT 1169	95	CAT 1296 B	138	CAT 1435	181	CAT 1562	224	CAT 1768 B	267	CAT 2050
10	CAT 1005	53	CAT 1171 A	96	CAT 1297	139	CAT 1437	182	CAT 1573	225	CAT 1773	268	CAT 2055
11	CAT 1009	54	CAT 1171 B	97	CAT 1302	140	CAT 1439	183	CAT 1607	226	CAT 178	269	CAT 2056
12	CAT 1014	55	CAT 1173	98	CAT 1305	141	CAT 1442	184	CAT 1610	227	CAT 1783	270	CAT 2058
13	CAT 1027	56	CAT 1175	99	CAT 1308	142	CAT 1452	185	CAT 1613	228	CAT 18 A	271	CAT 2066
14	CAT 1034	57	CAT 1176	100	CAT 1318	143	CAT 1453	186	CAT 1615	229	CAT 1810	272	CAT 2068 B
15	CAT 1045	58	CAT 1179	101	CAT 1321	144	CAT 1454	187	CAT 1622	230	CAT 1811	273	CAT 2070A
16	CAT 1058	59	CAT 1180	102	CAT 1323	145	CAT 1456	188	CAT 1631	231	CAT 1812	274	CAT 2070B
17	CAT 1060	60	CAT 1181 A	103	CAT 1324	146	CAT 1459	189	CAT 1633 A	232	CAT 1816	275	CAT 2072
18	CAT 1060 B	61	CAT 1182	104	CAT 1326	147	CAT 1354	190	CAT 1636	233	CAT 1820	276	CAT 2082
19	CAT 1062	62	CAT 1185	105	CAT 1328	148	CAT 1353	191	CAT 1641 B	234	CAT 1822	277	CAT 2083A
20	CAT 1065	63	CAT 1186	106	CAT 133	149	CAT 1352	192	CAT 1648	235	CAT 1826	278	CAT 2084
21	CAT 1077	64	CAT 1187	107	CAT 1330	150	CAT 1471	193	CAT 165	236	CAT 1831 B	279	CAT 2086A
22	CAT 1085	65	CAT 1191	108	CAT 1334	151	CAT 1476	194	CAT 1652	237	CAT 1843 B	280	CAT 2086B
23	CAT 1086	66	CAT 1193	109	CAT 1339	152	CAT 1477	195	CAT 1664	238	CAT 1847	281	CAT 2091
24	CAT 1091	67	CAT 1195	110	CAT 1341 A	153	CAT 1485	196	CAT 1673 A	239	CAT 1850	282	CAT 2092
25	CAT 1094	68	CAT 120	111	CAT 1341 B	154	CAT 1491	197	CAT 1673 B	240	CAT 1858	283	CAT 2094
26	CAT 1095	69	CAT 1200	112	CAT 1347	155	CAT 1493	198	CAT 1676	241	CAT 1878	284	CAT 2096B
27	CAT 1096	70	CAT 1202	113	CAT 1362	156	CAT 1504	199	CAT 1691	242	CAT 188	285	CAT 2100
28	CAT 1099	71	CAT 1208	114	CAT 1366	157	CAT 1507 B	200	CAT 1692	243	CAT 1881	286	CAT 2101
29	CAT 1103	72	CAT 1210	115	CAT 1368	158	CAT 1508 B	201	CAT 1694	244	CAT 1882	287	CAT 2104
30	CAT 1109	73	CAT 1211	116	CAT 1370	159	CAT 1511	202	CAT 1699	245	CAT 1894	288	CAT 1976
31	CAT 1112	74	CAT 1215	117	CAT 1371	160	CAT 1516	203	CAT 17	246	CAT 1898	289	CAT 1957
32	CAT 1113	75	CAT 122	118	CAT 1373	161	CAT 1517	204	CAT 1701	247	CAT 1899	290	CAT 195
33	CAT 1119	76	CAT 1224	119	CAT 1374 B	162	CAT 1518	205	CAT 1705	248	CAT 1916	291	CAT 194
34	CAT 1122	77	CAT 1228 A	120	CAT 1382	163	CAT 1521	206	CAT 171	249	CAT 1917	292	CAT 1936
35	CAT 1125	78	CAT 1229	121	CAT 1387	164	CAT 1523A	207	CAT 1710	250	CAT 192	293	CAT 1931
36	CAT 1128	79	CAT 1135	122	CAT 1391	165	CAT 1526	208	CAT 1713	251	CAT 1921A	294	CAT 1928B
37	CAT 1140	80	CAT 1136	123	CAT 1392	166	CAT 1527	209	CAT 1720	252	CAT 1927A	295	JS 20-34 (C)
38	CAT 1141	81	CAT 1238	124	CAT 1396	167	CAT 1529	210	CAT 1726 B	253	AGS 121	296	JS 95-60 (C)
39	CAT 1143	82	CAT 1241	125	CAT 1398	168	CAT 153	211	CAT 1582	254	CAT 1912	297	NRC 86 (C)
40	CAT 1145	83	CAT 1243B	126	CAT 140A	169	CAT 1530	212	CAT 1578	255	CAT 2005	298	NRC 37 (C)
41	CAT 1148	84	CAT 1248	127	CAT 1400	170	CAT 1533	213	CAT 1576	256	CAT 1987B		
42	CAT 1149	85	CAT 1254	128	CAT 1404	171	CAT 1539	214	CAT 1575	257	CAT 1993A		
43	CAT 1150	86	CAT 1255	129	CAT 1409	172	CAT 1540	215	CAT 1597	258	CAT 2006		

**Table 2:** Classification of 298 genotypes under study into distinct groups based on eleven qualitative characters in soybean

Character	Group	Serial number of genotypes included in the group	Number of genotypes
Hypocotyl colour	Purple	1, 2, 3, 4, 5, 6, 8, 9, 12, 13, 14, 15, 18, 19, 21, 23, 24, 27, 28, 29, 32, 33, 34, 35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,69,70,71,72,73,74, 75,76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 88, 90, 91, 92, 94, 95, 96, 97, 98, 99, 100, 102, 104, 105, 106, 108, 110, 111, 113, 115, 116, 117, 119, 120, 121, 122, 123, 124, 125, 128, 129, 132, 133, 135, 137, 138, 140, 141, 143, 144, 145, 146, 147, 153, 154, 155, 158, 160, 163, 164, 173, 174, 175, 176, 177, 179, 180, 181, 183, 184, 185, 186, 188, 189,190, 191, 192, 193, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 247, 248, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 263, 264, 265, 266, 267, 268, 269, 271, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 292, 293, 294, 295	236
	Green	7, 10, 11, 16, 17, 20, 22, 25, 26, 30, 31, 68, 87, 89, 93, 101, 103, 107, 109, 112, 114, 118, 126, 127, 130, 131, 134, 136, 139, 142, 148, 149, 150, 151, 152, 156, 157, 159, 161, 162, 165, 166, 167, 168, 169, 170, 171, 172, 178, 182, 187, 194, 246, 249, 250, 262, 270, 272, 291, 296, 297, 298	62
Flower Colour	Purple	1,2,3,4,5,6,8,9,12,13,15,18,19,20,21,23,24,26,27,28,29,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57, 58,59,60,61,62,63,64,65,66,67,69,70,71, 72,73,74,75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 88, 90, 91, 92, 94, 95, 96, 97, 98, 99, 100, 102, 104, 105, 106 ,108, 109, 111, 113, 115, 116, 117, 119, 120, 121, 123, 124, 125, 128, 129, 130, 131, 132, 133, 135, 137, 138, 140, 141, 143, 144, 145, 146 ,147, 152, 153, 154, 158, 160, 161, 162, 163, 164, 169, 173, 174, 175, 176, 177, 179, 180, 181, 183, 184, 185, 186, 188, 189, 190, 191, 192, 193, 195, 196, 198, 199, 200, 201, 202, 203 ,204, 205, 206, 207, 208, 209, 210, 211 ,212, 213, 214, 215, 216, 217, 218, 220, 221, 222, 223, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 247, 248, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 263, 264, 265, 266, 267, 268, 269, 271, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 292, 294, 295, 298	238
	White	7,10,11,14,16,17,22,25,30,31,68,87,89,93,101,103,107,110,112,114,118,122,126,127,134,136,139,142,148,149,150,151,155,156,157,159, 165,166,167,168,170,171,172,178,182,187,194,197,219,224,246,249,250,262,270,272,291,293,296,297,	60
Pubescence Colour	Gray	1,16,22,62,89,94,112,126,127,130,131,134,150,151,156,157,160,163,168,170,174,179,210,229,246	25
	Towny	2,3,4,5,6,7,8,9,10,11,12,13,14,15,17,18,19,20,21,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51 ,52,53,54,55,56,57,58,59,60,61,63,64,65,66,67,68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 90, 91, 92, 93, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110 ,111, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 128, 129, 132, 133, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 152 ,153, 154, 155, 158, 159, 161, 162, 164, 165, 166, 167, 169, 171, 172, 173, 175, 176, 177, 178, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 211, 212, 213, 214, 215 ,216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 297	271
	Light Brown	296, 298	2
Leaf shape	Broad	1,2,5,6,7,8,9,11,12,13,14,17,18,19,21,23,25,26,27,28,29,30,31,32,33,34,35,38,41,42,43,44,45,46,48,49,50,53,54,58,59,60,61,62,63,64,65,6 6,67,68,69,70,71,72,75,76,77,78,81,82,84,86,87,88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 99, 101, 102, 104, 105, 106, 107, 108, 110, 111, 112, 116, 118, 119, 120, 121, 122, 123, 124, 125, 126, 128, 129 ,130, 131, 133, 134, 135, 136, 137, 138, 139, 142, 143, 144, 145, 151, 152, 154, 155, 156, 157, 158, 159, 167, 170, 171, 172, 173, 176, 179, 180, 183, 184, 185, 186, 188, 189, 190, 191, 203, 204, 206, 207, 208, 209, 210, 215, 216, 217, 218, 219, 222, 223, 224, 225, 226, 227, 228, 229, 230, 232, 235, 237, 238, 240, 241, 242, 243, 244, 245, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 258, 259, 260, 261, 263, 264, 265, 266, 269, 270, 271, 273, 274, 275, 276, 278, 279, 281, 282, 284, 285, 286, 287, 288, 289, 290 ,291, 292, 293, 294, 295, 296, 297	207
	Intermediate	3,4,10,15,16,20,22,24,36,37,39,40,47,51,52,56,57,79,80,83,85,100,103,109,113,114,117,127,132,140,141,146,147,148,149,150,153,160,1	84

		61,162,163,164,165,166,168,169,174,175,177,178,181,182,187,192,193,194,195,196,197,198,199,200,201,202 205 211 212 213 214 220 231 233 234 236 239 246 257 262 267 268 272 277 280 283	
	Narrow	55, 73 , 74, 98, 115, 221, 298	7
Leaf colour	Dark Green	1,5,7,14,17,25,33,34,35,36,38,39,40,41,66,67,68,69,71,72,73,74,75,76,79,80,82,83,84,85,86,87,88,89,90,112,113,114,115,116,117,118,119,122,129,130,149,150,151,152,153,155,175,176,177,178,181,182,183,185,186,187,188,189,190,192,213,214,216,217,218,220,221,222,23,226,233,236,256,258,261,262,263,285,286,287,288,289,295,298	90
	Yellowish Green	2,3,4	3
	Light Green	6,8,9,10,11,12,13,15,16,18,19,20,21,22,23,24,26,27,28,29,30,31,32,37,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,70,77,78,81,91,92,93,94,95,96,97,98,99,100,101,102,103,104,105,106,107,108,109,110,111,120,121,123,124,125,126,127,128,131,132,133,134,135,136,137,138,139,140,141,142,143,144,145,146,147,148,154,156,157,158,159,160,161,162,163,164,165,166,167,168,169,170,171,172,173,174,179,180,184,191,193,194,195,196,197,198,199,200,201,202,203,204,205,206,207,208,209,210,211,212,215,219,224,225,227,228,229,230,231,232,234,235,237,238,239,240,241,242,243,244,245,246,247,248,249,250,251,252,253,254,255,257,259,260,264,265,266,267,268,269,270,271,272,273,274,275,276,277,278,279,280,281,282,283,284,290,291,292,293,294,296,297,	205
Pubescence density	Dense	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100,101,102,104,105,106,107,108,109,110,111,112,113,114,115,116,117,118,119,120,121,122,123,124,125,126,127,128,129,130,131,132,133,134,135,136,137,138,139,140,141,142,143,144,145,146,147,148,149,150,151,152,153,154,155,156,157,159,160,161,162,163,164,165,166,167,168,169,170,171,172,173,174,175,176,177,178,179,180,181,182,183,184,185,186,187,188,189,190,191,192,194,195,196,197,198,199,200,201,202,204,205,206,207,208,209,210,211,212,213,214,215,216,217,218,219,220,221,222,223,224,225,226,227,228,229,230,231,232,233,234,235,236,237,238,239,240,241,242,243,244,245,246,247,248,249,250,254,255,256,257,258,259,260,,261,262,263,264,265,266,267,268,269,270,271,272,273,274,275,276,277,278,279,280,281,282,283,284,285,286,287,288,289,290,291,292,293,294,295,297	289
	Sparse	103,158,193,203,251,252,253,296,298	9
Seed coat colour	Yellowish white	1,2,3,6,13,16,18,20,21,23,27,28,29,30,31,32,34,35,36,37,41,42,43,46,47,48,50,51,53,55,58,59,63,66,68,71,72,75,78,82,85,86,89,90,91,95,96,102,106,107,108,110,111,113,116,117,120,121,123,124,129,130,133,134,135,136,137,139,143,144,145,147,150,152,153,155,156,158,160,161,162,164,168,169,171,178,179,181,183,186,188,189,190,193,195,196,200,203,205,207,212,214,217,218,219,221,225,234,235,239,240,242,244,248,251,252,253,256,258,259,260,261,262,263,264,265,266,268,269,270,271,273,275,276,277,279,280,281,282,285,286,287,289,296,297,	145
	Yellow	4,5,8,9,10,15,19,22,26,38,40,45,54,62,74,79,83,84,87,88,93,94,99,101,112,114,118,126,131,142,151,159,165,166,167,170,172,173,174,176,177,180,191,194,204,206,209,210,211,215,216,220,223,227,228,229,230,233,238,241,245,246,247,254,255,274,283,284,294,295,298	71
	Chocolate	7,14,25,76,182,187,199,249,291,	9
	Green	11,12,17,24,33,52,56,57,60,61,64,65,80,81,97,98,103,105,125,127,138,148,149,157,192,197,201,202,208,224,231,236,250,257,267,278,	36
	Black	39,44,49,67,69,70,73,77,92,100,104,109,115,119,122,128,132,140,141,146,154,163,175,184,185,198,213,222,226,232,237,243,272,288,290,292,293,	37
Hilum colour	Yellow	1,3,7,13,14,16,18,21,25,28,34,36,41,42,43,47,48,50,51,54,55,58,59,63,65,75,76,78,82,86,89,90,91,95,96,105,106,107,108,110,112,116,120,121,123,126,127,130,131,133,134,143,144,145,147,150,153,156,157,164,172,173,177,179,181,182,187,199,200,207,212,224,225,227,228,233,234,240,242,244,248,249,250,256,258,259,260,262,263,264,265,266,268,269,270,273,275,276,277,279,280,282,285,286,287,289,290,291,295,297,298	111
	Black	2,4,5,6,8,9,10,11,12,15,17,19,20,22,23,24,26,27,30,32,33,35,37,38,39,40,44,45,49,52,53,56,57,60,61,62,64,66,67,68,69,70,71,72,73,74,77,79,80,81,83,84,85,87,88,92,93,94,97,98,99,100,102,103,104,109,111,113,114,115,117,118,119,122,124,128,129,132,135,136,137,138,139,140,141,142,146,148,149,151,154,155,159,161,162,163,165,166,167,168,169,174,175,176,184,185,188,189,190,191,192,193,194,195,196,197,198,201,202,203,206,208,209,210,211,213,214,215,216,217,218,219,221,222,226,229,230,231,232,235,236,237,238,239,241,243,2	167



		46,247,251,252,253,254,255,257,261,267,271,272,274,278,283,284,288,292,293,294,296	
	Brown	29,31,46,101,125,152,158,160,170,171,178,180,183,186,204,205,220,223,245,281,	20
Pod colour	Tan	1,3,6,11,12,13,16,18,21,34,36,41,42,43,47,48,49,50,51,54,55,58,59,63,65,75,76,78,82,86,89,90,91,95,96,105,106,107,108,110,112,116,120,121,123,126,130,131,133,134,143,144,145,147,150,153,156,157,161,164,172,173,177,179,181,182,187,199,200,207,212,224,225,227,228,233,234,240,242,244,248,249,250,256,258,259,260,262,263,264,265,266,268,269,270,273,275,276,277,279,280,282,285,286,287,289,290,291,296,297	110
	Black	2,4,5,8,9,15,19,20,22,23,24,26,27,30,32,33,35,37,39,44,45,46,52,56,60,61,64,67,68,69,70,71,72,73,77,79,84,87,88,92,97,98,100,103,104,109,111,114,119,122,124,127,128,129,132,135,138,140,141,146,148,149,151,154,159,175,184,185,189,192,198,201,202,208,213,214,221,222,226,232,236,237,243,257,267,274,288,292,293,295,298,	91
	Brown	7,10,14,17,25,28,29,31,38,40,53,57,62,66,74,80,81,83,85,93,94,99,101,102,113,115,117,118,125,136,137,139,142,152,155,158,160,162,163,165,166,167,168,169,170,171,174,176,178,180,183,186,188,190,191,193,194,195,196,197,203,204,205,206,209,210,211,215,216,217,218,219,220,223,229,230,231,235,238,239,241,245,246,247,251,252,253,254,255,261,271,272,278,281,283,284,294,	97
Pod shattering	Non Shattering	1,2,3,7,8,9,10,11,13,15,16,17,20,21,22,23,24,25,28,29,30,31,33,34,35,36,38,39,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,57,58,59,61,62,63,64,65,66,67,69,70,72,73,74,75,77,78,80,81,82,84,86,87,88,90,91,93,96,97,98,99,101,103,104,105,106,107,108,109,110,111,112,113,114,115,116,117,118,119,120,121,122,123,124,126,127,128,130,132,133,134,135,136,137,138,139,140,141,142,143,144,145,146,147,148,149,150,151,152,153,155,156,158,159,160,161,162,163,164,165,166,167,168,169,170,171,172,173,174,175,176,178,179,180,181,182,183,184,185,186,187,188,189,192,193,194,196,197,198,199,200,201,202,204,205,208,209,210,211,212,213,215,216,217,218,221,222,225,226,227,228,229,230,231,232,233,234,237,238,239,240,241,242,243,244,248,249,250,252,255,256,258,259,260,262,263,264,265,266,268,269,270,271,273,274,275,276,277,278,279,280,282,283,284,285,286,287,289,290,291,292,293,294,295,296,297,298	241
	Shattering	4,5,6,12,14,18,19,26,27,32,37,40,56,60,68,71,76,79,83,85,89,92,94,95,100,102,125,129,131,154,157,177,190,191,195,203,206,207,214,219,220,223,224,235,236,245,246,247,251,253,254,257,261,267,272,281,288,	57
Growth habit	Determinate	2,3,5,6,7,8,9,10,11,12,13,14,15,16,17,18,20,21,22,23,24,26,27,28,29,30,32,33,34,35,36,38,41,42,43,45,46,47,48,49,50,51,52,53,54,58,59,61,62,63,65,66,71,72,75,76,78,81,85,86,87,88,89,90,91,93,94,96,97,98,99,101,102,103,106,107,108,110,111,112,113,114,116,117,118,120,121,122,123,124,129,130,131,132,133,134,135,136,137,138,142,143,144,148,149,150,151,153,155,156,157,159,160,161,162,163,164,165,166,167,168,169,170,171,172,173,174,177,178,179,180,181,182,186,187,188,189,190,192,194,195,196,197,199,200,204,205,206,207,209,210,211,212,213,215,216,218,219,220,223,224,225,226,227,228,233,234,238,239,240,242,243,244,246,247,248,249,250,251,252,253,254,255,256,258,259,260,261,262,263,264,265,266,267,268,270,271,272,273,274,275,276,277,278,280,281,282,283,285,286,287,289,290,293,294,295,296,297,298	219
	Semi Determinate	1,4,25,31,37,40,55,56,57,60,64,67,68,69,77,79,80,82,83,84,92,95,100,104,105,125,126,127,141,145,146,147,152,154,158,175,176,191,193,201,202,217,230,231,236,237,241,245,269,279,284,291,292	53
	Indeterminate	19,39,44,70,73,74,109,115,119,128,139,140,183,184,185,198,203,208,214,221,222,229,232,235,257,288,	26

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