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Agronomic Characteristics and Seed Yield of Indonesian Mungbean (*Vigna radiata*) Genetic Resources

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Authors' contributions

This work was carried out in collaboration among all authors. Authors RS, RTH, NN and MJM designed the study. Authors RS, RTH, NN, PH and MJM performed the statistical analysis and wrote the protocol. Authors RS, RTH, Suhartina and MJM wrote the first draft of the manuscript. Authors RS, RTH, Trustinah, Suhartina and MJM managed the analyses of the study. Authors RS, RTH, NN, Trustinah and MJM managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The availability of mungbean (*Vigna radiata*) genetic resources is important in breeding programs for development of new improved varieties. The objective of this study was to describe the characters of 300 accessions of ILETRI's mungbean genetic resources collections. The study was conducted in Jambegede Experimental Station, East Java, Indonesia during dry season 2018. The results showed that the descriptive characters of 300 mungbean germplasm accessions had a fairly wide range, namely 50%-flowering date ranged from 30-50 days after planting with an average of 41.92 days, Pod maturity ranged from 50 - 88 days after planting with an average of 74.08 days, 100-seed weight ranged from 2.43 to 7.96 g with an average of 4.52 g, and Seed weight per plot ranged from 10 - 525 g with an average of 254.53 g. There were three accessions with seed size more than 7.5 g/100 seeds, namely MLGV 0713, MLGV 0960, and MLGV 1027. These accessions could be used as a source of genes for developing high yielding and large seed size of new improved

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mungbean varieties. Furthermore, the high diversity data in mungbean collection can provide information to used by breeders.

Keywords: Traits; mungbean; genetic resources; diversity; breeding program.

1. INTRODUCTION

Mungbean (*Vigna radiata*) is one of the most important food and cash legume crops in South, East and Southeast Asia. This area produces approximately 90% of the world production. The plant has severaladvantages in terms of agronomy, economy and nutrition compared to other legume crops. Mungbean is relatively drought tolerant and its cultivation is relatively easy. It has a short crop duration suitable for intercropping, and can improve soil fertility by forming nodules. In terms of nutrition, mungbean seeds contain easily digestible protein, carbohydrates, flavonoids, phenolic acids, amino acids, lipids, and other minerals that are very good for health [1, 2]. The origin of mungbean is believed to be India and domestication took place approximetly 3,500 years ago based on domesticated mungbean diversity data and archeological evidence.

The availability of mungbean germplasm as a genetic resource is important in breeding programs. The diverse gene pool of wild mungbean comprises of valuable genetic resources which are helpful in widening the genetic diversity of cultivated mungbean Plant genetic resources can be conserved (conservable) and not spent (renewable), but it is important to note that once the genetic resources are lost, they cannot be recovered and/or revived [3]. The improvement of mungbean yield components to increase productivity through the assembly of ideal plant shapes requires information on the characteristics needed in the germplasm collection. These characteristics include:large seed size, number of pods per plant, 100-seed weight, and yield a. According to Gayacharan et al. [4] the economically important traits in mungbean are seed weight, flowering period, pod length, number of seeds/pod, and seed size.

The germplasm collection which contains large accessions are managed by conservation and utilization. Germplasm conservation helps preserve knowledge about extinct, wild, and other living species of a crop plant which have been eroded due human interference totally eliminating the desirable genetic materials. It is mainly concerned with ensuring the secure handling and proper preservation of germplasm of commercially valuable plants by collecting accessions.

Information about the characters from the collection is very useful for breeders to plan their breeding program. Characterization and evaluation are important activities for utilization of germplasm in crop improvement programs. Characterization is the description and establishment of diagnostic characters of a plant germplasm. Generally, characterization traits are highly inheritable and qualitative in nature. Evaluation is the description of plant germplasm expression in adverse environmental conditions revealling its potential. Evaluation traits are quantitative in nature but are highly important for crop improvement. The major objective of the evaluation is to identify trait-specific germplasm. In general, it is notable that characterization and preliminary evaluation (for yield and its components) is conducted simultaneously while evaluation for biotic and abiotic stresses is done separately [4].

In Indonesia, utilization of mungbean germplasm is very important in producing new superior varieties. There are 26 varieties of mungbean have been released. The varieties of Vima-1, Vima-2, Vima-3, Vima-4, Vima-5, Vimil-1, and Vimil-2 were released by using parents from ILETRI's Genetic resources Collection (IGC). From the IGC a total of 13 varieties of mungbean were produced from purification and/or selection of introduced lines (Bhakti, No.129, Merak, Nuri, Manyar, Walet, Gelatik, Merpati, Sriti, Kenari, Murai, Perkutut, and Kutilang), and other three varieties from local varieties (Siwalik, Arta Ijo, and Sampeong). Research has shown that the IGC plays an important role in providing gene sources for developing superior varieties of mungbean.

The objective of the study was characterilize the 300 accessions of ILETRI's mungbean genetic resources collection.

2. MATERIALS AND METHODS

2.1 Research Site

The experiment was conducted in the Jambegede Research Station, Malang, East

Java, Indonesia with an altitude of 335 meters above sea level at the coordinates of 8°10'30"S 112°33'32.4"E. The experiment was conducted during Dry Season (March-June 2018).

2.2 Plant Genetic Materials

A total of 300 mungbean accessions were planted without replication. A plot size of 4.8 m^2 (3 rows of 4 m long) was planted to each accession with a spacing of 40 cm between rows and 10 cm between plants within a row with two plants per hill. The plants were fertilized using Urea 45 kg, SP36 50 kg and KCl 50 kg per hectare. The recommended agronimic practices for optimum mungbean growth were followed in crop management. Weeding were done intensively. Irrigation was applied based on recommendation, while pest / disease control was carried out in accordance with monitoring in order to obtain normal and optimal plant growth.

2.3 Data Collection

Hypocotyl color was recorded seven days after planting. , Days to flowering and maturity were recorded when 50% of plants showed open flowers and 80% matured pods. At maturity, ten plants were randomly selectedfor pod color, seed color, seed shining, 100-seed weight (g). Seed yield per plot (g) was observed fyield in the whole plot with 12% moisture content.

2.4 Data Analysis

Data observed of flowering, pod maturity, 100-seed weight and yield per plot were analyzed using Minitab 14.0 program to calculate maximum, minimum and standard deviation values. Histograms were made for qualitative parameters.

3. RESULTS AND DISCUSSION

3.1 Conservation Mungbean Genetic Resources

The diversity of the 300 mungbean accessions is quite wide as illustrated in appendix 1. The descriptive quantitative characters of 300 mungbean accessions are shown in Table 1. Most mungbeen accessions at 50% flowering ranged from 30-50 Days After Planting (DAP) with an average of 41.92 DAP, while pod maturity ranged from 50 – 88 DAP with an average of 74.08 DAP. On yield components, 100-seed weight ranged from 2.43 to 7.96 g with an average of 4.52 g and seed yield per plot ranged from 10 - 525 g with an average of 254.53 g. Similar results have been reported byAbna et al's [5] on eight morphological characters of mungbean. These characters showed significant differences among 20 genotypes of mungbean tested. The characters included:plant height, number of fruiting branches per plant, number of pods per plant, number of pod clusters per plant, pod length, number of seeds per pod, 1000-seed weight and total seed yield per plant.

Diversity of qualitative characters of mungbean accessions can be seen in the histogram below. The frequency distribution of the hypocotyl color of mungbean accessions is grouped into three classes, namely green (68 accessions), purple (218 accessions) and mix /green and purple (14 accessions)(Fig. 1). In the frequency distribution of pod color, black pods dominated with 275 accessions, 18 accessions with brown pod and 7 accessions with mixed color (black and brown) pods (Fig. 2). Similarly, the distribution of seed color is widely varied , they were 177 accessions with dull green seed color, 51 accessions with shiny green seed color, 24 accessions with dull brown seed color, 2 accessions with dull yellow seed color, 1 accession with shiny yellow seed color, and 45 accessions with mixed colors (Fig. 3). In the studies of Wanga et al. [6] identified accessions with beneficial traits, such erect habit, dwarfed plants, and increased pods per plant. In addition, among the soybean genotypes they were found to be have genetic diversity, (Jain et al. [7]). Diverse germplasm accessions increase genetic diversity in soybean breeding programs and preserve the rare alleles. Understanding the genetic diversity of germplasm sets is important for determining effective strategies that improve economic traits for crop development. According toWin et al. [8] on evaluation of 185 mungbean accessions, showed significant genetic diversity among the tested accessions and this provided a good chance for the selection of parents for the improvement program.

Beside productivity, most farmers' preferences for mungbean varieties is based on appearance aspects such as seed color (dull or shiny), seed size (small, large), and price [9]. Yimram et al. [10] reported that in mungbean commodity, qualitative characters play an important role in

determining consumer preferences. In Thailand, consumers prefer green color over yellow. and having green hypocotyl color over purple for the sprouts industry. The color of black pods is preferable to brown because it can retain the color of the seeds longer when in the field (they do not fade easily). In Indonesia, the green color of mungbean is also more desirable, but for the food processing industry, the color of the seeds does not have much effect because peeled mungbean are more desirable.

Flowering and maturity date of mungbean accessions are wide as shown in Figs. 4 and 5. In future, grouping of accessions based on maturity date is important. Based in our findings, it can be deduced that the majority of acessions planted this season are medium to late maturity. However, mungbean varieties released in Indonesia, mostly mature in less than 65 days after planting [11]. In this study we found, there were 25 accessions maturing less than 65 days after planting.

Table 1. Descriptive statistics of quantitative characters of 300 mungbean accessions of IGC at Jambegede, 2018

Character	Minimum	Maximum	Mean	Standard deviation
50 % flowering *	30.00	50.00	41.92	4.61
80 % pod maturity*	50.00	88.00	74.08	8.31
100-seed weight (g)	2.43	7.96	4.52	1.16
Yield per plot (g)	10.00	525.00	254.53	103.21

**DAP : days after planting*

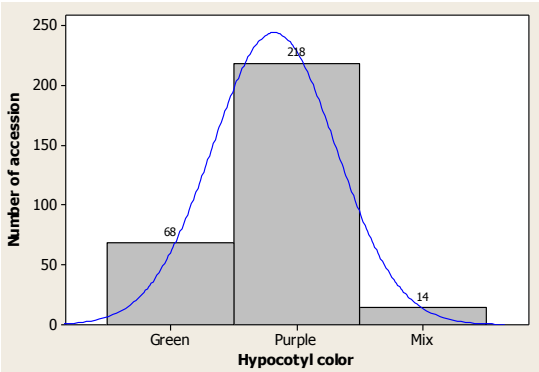

Fig. 1. Histogram of hypocotyl colour of 300 mungbean accessions

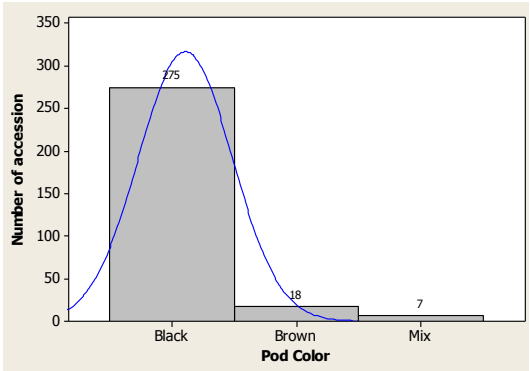

Fig. 2. Histogram of pod colour of 300 mungbean accessions

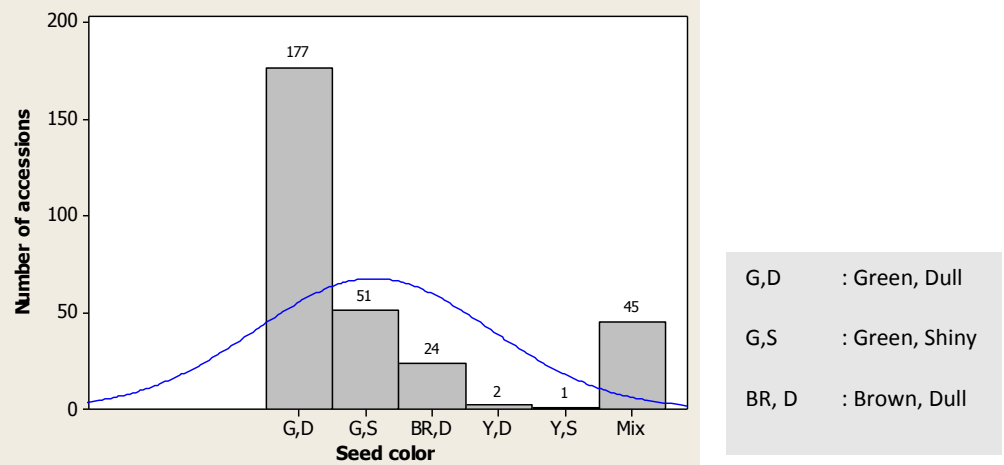

Fig. 3. Histogram of seed colour of 300 mungbean accessions

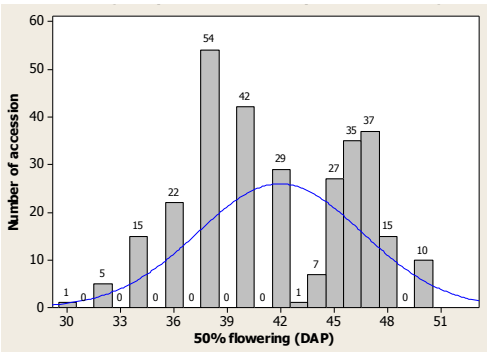

Fig. 4. Histogram of 50 % flowering of 300 mungbean accessions

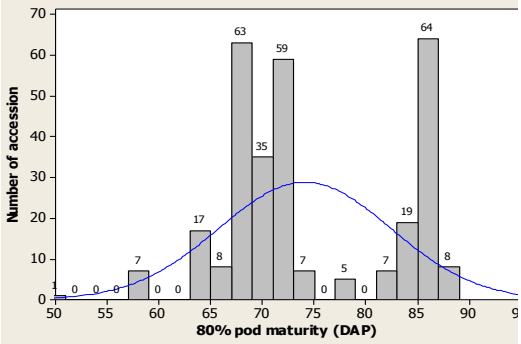

Fig. 5. Histogram of 80 % pod maturity of 300 mungbean accessions

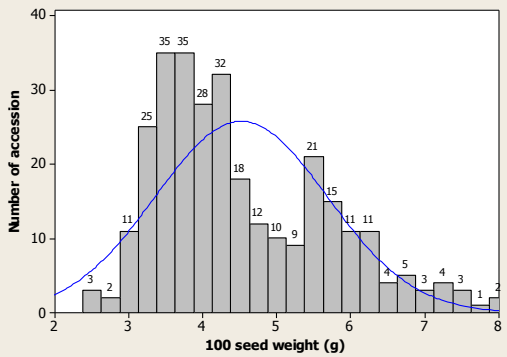

Fig. 6. Histogram of 100- seed weight (g) of 300 mungbean accessions

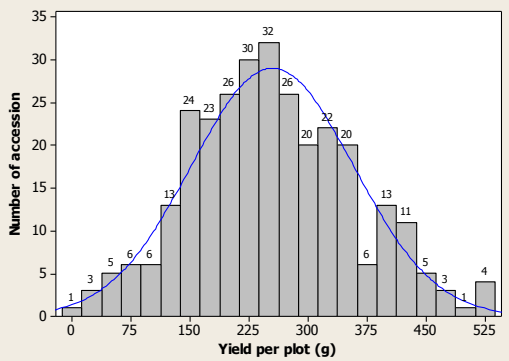

Fig. 7. Histogram of yield per plot (g) of 300 mungbean accessions

The seed size of mungbean is grouped into three classes, namely large (> 61 g / 1000 seeds), medium (50–60 g / 1000 seeds), and small (<50 g / 1000 seeds). Based on this classification, the average seed size in the collection were classified into small to medium seeds (Fig. 6). The average yield/ plot is 254.53 g. There are 98 accessions can be harvested simultaneously at harvesting, while the rest can be harvested up to 2 times (Fig. 7).

Begum et al. [12] reported that days to flowering of mungbean ranged from 42.0 to 67.25 days, days to maturity ranged from 78.25-105.50 days, 100-grain weight was 3.22 g to 5.85 g and grain yield per plant was 27.72-45.35 g. Plant growth parameters of days to flowering, days to maturity and100-grain weight can be recommended as selection indices for high yield and genotypes. The study of Schafleitner et al. [13] showed that phenotypic characters of AVRDC (World Vegetable Center) mungbean collection for days to 50% flowering ranged from 39-73 DAP, days to 80% maturity 48-110 DAP, number of primary branches 1-9, number of seeds per pod 5.8-15.4, pod lenght 5-17.1 cm, seed size (100 seed weight 2.03-7.58 g).

On visual assessment of plant condition, Wanga et al. [6] reported that among the 184 accessions, green seeds accounted for 78% and black seeds for 13%. brown, yellow and dotted seed coats accounted for 3%, 4%, and 3%, respectively. Seed testa with glossy surfaces accounted for 76% and those with dull surfaces for 22%. Not all accessions completed their life cycles. The study further showed that three accessions from India (PI 363489, PI 426128, and PI 363291) flowered but did not set seeds, while two (PI 427260 from Nepal and PI 363212 without passport information) did not flower. The growth periods of the 179 accessions varied from 82 to 121 days, with an average of 98.4 days. Pod length varied from 4.4 cm to 15.8 cm with a mean of 7.3 cm. The original 100-seed weight varied from 0.82 g to 6.96 g with an average value of 3.42 g. There was a marked increase in the weights of newly harvested seeds, ranging from 1.64 to 7.30 with an average value of 3.87. Of the accessions, 60% showed a 10% increase and 22% a decrease in seed weight.

It is of principal interest that resistance to pest and diseases for mungbean genotypes is evaluated. A number of 162 mungbean genotypes have been screened and showed their diversity for resistance to mungbean diseases [14,15,16]. Genetic diversity in mungbean genotypes have been reported that principal component and cluster analysis displaythe closeness of the local and exotic genotypes [17,18,19,20,21,22].

4. CONCLUSION

There was a genetic diversity among agronomic and seed yield characters of mungbean genotypes. Three accessions (MLGV 0713, MLGV 0960, and MLGV 1027) had 100-seed weight more than 7.5 g and could be used as parents in the mungbean breeding programe at ILETRI. The high diversity data in mungbean collection can provide information for its use for breeders.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Appendix 1. Characteristics of 300 mungbean accessions at the ILETRI

No.	MLGV accessions code	Hypocotyl colour	50 % flowering date	80 % pod maturity	Pod colour	Seed colour	100-seed weight (g)	Yield per plot (g)
1	105	G	36	58	BL	G,S	5.5	285
2	108	G	34	64	BL	G,S	6.2	305
3	170	G	40	68	BL	G,D	5.23	350
4	282	P	40	68	BL	G,S	4.76	320
5	340	P	42	72	BL	G,D	3.31	300
6	351	G	36	64	BL	G,S	6.21	240
7	354	G	36	65	BL	G,S	5.74	310
8	377	P	36	68	BL	G,S	5.46	430
9	378	G	40	67	BL	G,D	4.47	450
10	391	P	40	67	BL	MX	5.61	305
11	392	P	40	68	BL	G,D	4.48	265
12	393	G	40	66	BL	G,S	7.18	245
13	394	P	40	72	BL	G,S	5.44	350
14	395	G	40	68	BL	G,S	6.16	300
15	401	P	47	84	BL	G,D	4.67	150
16	402	P	36	68	BL	G,D	3.1	400
17	422	G	40	67	BL	G,D	5.18	390
18	425	P	40	73	BL	G,S	4.24	390
19	426	G	40	68	BL	G,S	5.58	240
20	429	G	36	64	BL	Y,S	4.2	245
21	433	P	36	67	BL	G,D	3.47	165
22	434	P	47	72	BL	G,D	3.65	525
23	448	P	40	67	BL	G,D	3.01	415
24	450	P	40	72	BL	G,D	3.6	400
25	456	P	42	73	BL	G,S	4.9	295
26	462	G	38	71	BL	MX	6.9	370
27	467	P	36	67	BL	MX	2.81	410
28	493	P	40	68	BL	G,S	2.45	525
29	520	G	40	66	BL	G,S	4.66	395
30	523	G	40	66	BL	G,S	5.74	400
31	529	P	45	72	BL	G,D	4.63	455
32	531	P	42	72	BL	G,D	5	300
33	534	P	47	72	BL	G,D	3.81	330
34	551	P	47	71	BL	G,D	3.74	235
35	556	P	45	71	BL	G,D	3.82	190
36	561	P	47	71	BL	G,D	3.98	520
37	562	P	46	82	BL	G,D	3.67	175
38	572	P	47	82	BL	G,D	3.4	315
39	574	P	46	82	BL	G,D	3.49	405
40	578	P	47	82	BL	G,D	3.56	245
41	580	P	45	67	BL	G,D	3.92	335
42	583	P	40	68	BRW	MX	4.46	425
43	587	P	46	72	BL	MX	4.09	440
44	588	P	42	82	BL	BR,D	3.08	345
45	594	P	42	72	BL	G,D	4.78	335
46	596	P	40	72	BL	BR,D	3.25	355
47	597	P	40	82	BL	G,D	4.51	405
48	598	P	42	66	BL	G,D	4.34	230
49	599	P	38	67	BL	MX	4.45	345

No.	MLGV	Hypocotyl	50 %	80 % pod	Pod	Seed	100-seed	Yield
50	600	P	47	67	BL	G,D	3.92	365
51	602	P	46	66	BL	MX	3.01	390
52	603	P	40	66	BL	G,D	3.28	430
53	605	P	45	71	BL	MX	7.38	370
54	608	P	46	85	BL	MX	3.5	495
55	609	P	45	72	BL	G,D	4.29	440
56	610	P	45	85	BL	MX	4.02	185
57	611	P	45	72	BL	MX	3.85	310
58	613	P	47	86	BL	G,D	3.44	355
59	614	P	42	84	BL	MX	3.24	345
60	617	P	47	85	BL	G,D	3.61	355
61	627	P	42	84	BL	MX	3.33	285
62	628	P	45	85	BL	MX	3.8	155
63	629	P	42	84	BL	MX	3.18	160
64	630	P	47	85	BL	G,D	3.93	485
65	633	P	47	85	BL	MX	3.43	365
66	642	P	47	85	BL	G,D	3.39	430
67	643	P	47	84	BL	BR,D	3.74	455
68	644	P	45	85	BL	G,D	3.55	115
69	645	P	46	84	BL	G,D	3.3	320
70	646	P	45	84	BL	G,D	3.5	185
71	647	P	46	85	BL	G,D	3.37	310
72	648	P	45	85	BL	MX	4.25	435
73	649	P	46	85	BL	G,D	7.42	260
74	650	P	47	85	BL	BR,D	3.44	340
75	651	P	47	85	BL	G,D	3.45	320
76	652	P	46	84	BL	G,D	3.76	410
77	654	P	47	85	BL	G,D	3.23	270
78	655	P	46	85	BL	G,D	3.71	355
79	676	P	47	84	BL	BR,D	3.56	525
80	677	P	47	85	BL	MX	3.42	325
81	680	P	40	67	BL	G,D	5.94	295
82	681	G	38	67	BL	G,D	5.49	245
83	688	P	38	66	BL	G,D	3.51	360
84	689	P	42	83	BL	G,D	3.51	280
85	690	P	45	68	BL	G,D	3.35	370
86	692	P	46	68	BL	G,D	3.52	315
87	693	P	45	84	BL	G,D	3.83	420
88	694	P	46	84	BL	G,D	2.89	150
89	695	P	47	85	BL	G,D	3.49	470
90	697	P	45	86	BL	BR,D	4.29	235
91	698	P	46	86	BL	G,D	3.55	205
92	699	P	47	86	BL	G,D	3.04	160
93	700	P	48	86	BL	G,D	3.55	115
94	702	P	50	86	BL	G,S	3.09	135
95	705	P	50	86	BL	G,D	3.23	290
96	707	P	47	86	BL	BR,D	7.38	365
97	708	P	46	85	BL	BR,D	3.72	320
98	709	P	46	85	BL	BR,D	3.72	245
99	710	P	46	85	BL	BR,D	3.78	270
100	711	P	47	86	BL	BR,D	3.86	290
101	712	P	46	86	BL	BR,D	4.7	315
102	713	P	47	86	BL	BR,D	7.71	205
103	714	P	48	86	BL	BR,D	3.31	260
104	719	P	48	86	BL	G,D	3.9	120
105	720	P	46	73	BL	G,D	3.48	230

No.	MLGV	Hypocotyl	50 %	80 % pod	Pod	Seed	100-seed	Yield
106	721	P	40	72	BL	G,D	3.51	195
107	722	P	40	84	BL	G,D	3.41	225
108	723	P	46	84	BL	G,D	4.11	105
109	725	G	45	84	BL	G,D	3.98	245
110	726	P	47	84	BL	G,D	4.26	160
111	727	P	42	72	BL	G,D	3.52	225
112	728	P	47	85	BL	G,D	3.3	160
113	730	P	44	85	BL	G,D	4.48	145
114	731	P	45	85	BL	G,D	3.91	200
115	732	P	48	85	BL	BR,D	3.79	85
116	733	P	47	86	MX	BR,D	4	135
117	734	P	46	85	BL	BR,D	4.2	105
118	735	P	45	86	BL	G,D	4.05	175
119	736	P	42	86	BL	BR,D	3.34	135
120	737	G	44	83	BL	G,D	4.31	250
121	738	P	40	82	BL	G,D	3.73	280
122	744	P	45	86	BL	G,D	4	230
123	746	P	42	86	BL	G,D	4.35	135
124	747	P	44	72	BL	G,D	4.26	305
125	750	P	42	72	BL	G,D	4.36	210
126	753	P	42	72	BL	G,D	3.72	205
127	754	P	40	72	BL	G,D	3.73	335
128	755	P	42	71	BL	G,D	3.29	210
129	756	P	47	71	BL	G,D	3.88	170
130	757	P	45	71	BL	G,D	3.28	160
131	758	P	46	71	BL	G,D	4	175
132	759	P	47	73	BL	BR,D	3.58	260
133	760	P	48	86	BL	G,D	3.28	150
134	761	P	46	72	BL	G,D	3.65	235
135	762	P	42	72	BL	G,D	3.66	360
136	765	P	47	88	BL	G,D	4.23	85
137	768	P	45	72	BL	G,D	3.5	250
138	770	P	47	72	BL	G,D	3.79	190
139	771	P	42	72	BL	G,D	3.19	240
140	772	P	40	86	BL	G,D	4.14	270
141	773	P	47	86	BL	G,D	3.84	340
142	774	P	43	71	BL	G,D	3.98	310
143	775	P	44	71	BL	G,D	4.03	280
144	776	P	44	86	BL	G,D	3.76	285
145	777	P	42	71	BL	G,D	4.38	240
146	778	P	40	84	BL	G,D	5.25	145
147	779	P	48	72	BL	G,D	4.13	225
148	780	P	44	72	BL	G,D	3.53	225
149	783	P	46	86	BL	BR,D	3.55	150
150	784	P	46	72	BL	BR,D	3.98	245
151	785	P	46	86	BL	BR,D	3.69	190
152	787	P	47	86	BL	G,D	4.48	150
153	788	P	47	86	BL	G,D	4.12	140
154	792	P	46	71	BL	G,D	4.45	175
155	793	P	45	86	BL	G,D	4.51	95
156	794	P	47	86	BL	G,D	3.98	120
157	796	P	42	72	BL	G,D	4	220
158	797	P	45	72	BL	G,D	3.8	210
159	798	P	45	86	BL	G,D	4.14	240
160	799	P	46	86	BL	G,D	4.42	230
161	800	P	45	86	BL	MX	4.33	105

No.	MLGV	Hypocotyl	50 %	80 % pod	Pod	Seed	100-seed	Yield
162	803	P	44	85	BL	BR,D	3.42	175
163	804	P	47	87	BL	G,D	4.36	200
164	805	P	45	86	BL	G,D	4.22	270
165	806	P	50	85	BL	G,D	4.17	300
166	810	P	50	85	BL	G,D	4.2	315
167	811	P	42	71	BL	G,D	4.01	395
168	856	P	46	68	BL	MX	5.02	230
169	889	P	40	68	BL	MX	3.6	420
170	894	P	40	68	BL	MX	5.61	295
171	900	P	42	71	BL	G,D	6	215
172	901	P	42	72	BL	G,D	5.71	205
173	902	P	40	68	BL	MX	4.68	255
174	903	MX	38	68	BRW	G,D	4.48	185
175	908	P	42	68	BL	MX	2.5	285
176	909	P	40	68	BL	MX	2.43	350
177	911	MX	38	68	BL	G,S	4.01	330
178	913	MX	36	57	BL	G,D	6.3	305
179	914	G	36	68	BL	G,D	3.71	400
180	915	G	34	68	BL	MX	4.19	335
181	916	MX	36	68	BL	MX	4.16	350
182	917	MX	36	68	BL	G,D	3.22	350
183	918	MX	40	72	BL	MX	4.41	435
184	919	MX	38	68	BL	G,D	4.35	475
185	921	P	38	64	BL	MX	4.38	330
186	922	P	38	68	BL	MX	2.69	305
187	928	P	38	68	BL	MX	3.65	255
188	930	P	40	68	BL	G,D	3.91	205
189	932	G	36	68	MX	G,S	4.42	225
190	933	G	34	58	BL	G,S	6.66	285
191	934	G	38	68	BL	G,S	6.12	285
192	935	G	38	68	BL	G,S	5.47	290
193	938	G	36	68	BL	G,D	5.29	260
194	939	G	38	68	BL	G,D	4.19	290
195	940	P	38	68	BL	G,D	4.37	260
196	941	G	42	68	BL	G,D	4.97	230
197	942	G	38	68	BL	G,D	5.38	270
198	943	G	36	68	BL	G,S	6.17	205
199	944	G	40	68	BL	G,D	5.7	355
200	945	G	34	68	BL	G,D	5.07	330
201	946	G	36	57	BL	G,S	6.23	265
202	947	G	36	68	MX	G,D	5.46	425
203	948	G	38	68	BL	G,D	5.79	415
204	949	G	36	68	BL	G,D	5.77	175
205	950	G	38	68	BL	G,D	6.05	315
206	953	G	34	58	BL	G,S	6.77	125
207	954	P	48	71	BL	G,D	4.13	165
208	956	P	40	71	BL	G,S	3.91	65
209	957	P	34	63	BL	G,D	3.95	275
210	960	P	40	78	BL	G,S	7.96	230
211	962	P	46	78	BL	G,D	2.99	220
212	963	P	34	78	BL	G,D	3.84	195
213	965	P	34	78	BL	G,D	4.18	230
214	966	P	38	84	BL	G,D	7.17	10
215	967	P	38	78	BL	G,D	5.9	210
216	968	MX	47	85	BL	MX	3.66	50
217	969	MX	34	64	BL	G,S	5.57	225

No.	MLGV	Hypocotyl	50 %	80 % pod	Pod	Seed	100-seed	Yield
218	970	MX	38	64	BL	G,D	4.58	205
219	978	P	32	64	BL	G,D	3.76	185
220	983	P	38	72	BL	G,D	4.49	55
221	986	P	45	72	BL	MX	3.37	100
222	987	MX	48	86	BL	G,S	4.35	205
223	988	MX	45	86	BL	MX	3.17	40
224	989	MX	48	87	BL	MX	3.13	170
225	991	P	48	71	BL	G,D	6.32	130
226	992	P	46	72	BL	MX	3.53	275
227	993	P	46	72	BL	MX	3.33	165
228	994	P	46	72	BL	MX	3.1	270
229	995	P	48	72	BL	G,D	3.35	220
230	996	P	48	73	BL	G,D	4.66	145
231	997	P	48	73	BL	BR,D	3.26	200
232	998	P	48	73	BL	G,S	4.07	230
233	1002	G	38	69	BL	G,S	5.53	255
234	1003	G	36	69	BL	MX	5.79	230
235	1006	G	38	69	BL	MX	4.95	315
236	1011	G	32	69	BL	G,S	6.18	235
237	1015	G	34	69	BL	G,S	6.68	285
238	1017	MX	32	69	BL	G,S	5.12	265
239	1020	P	32	64	BL	G,S	7.09	245
240	1021	G	38	69	BL	G,S	5.47	190
241	1022	G	38	69	BL	G,S	5.4	350
242	1023	P	30	50	BL	G,S	5.46	255
243	1024	G	40	69	BL	MX	3.65	180
244	1025	G	38	69	BL	MX	5.37	245
245	1027	P	38	64	BRW	G,D	7.96	245
246	1028	P	40	69	BL	G,D	3.65	190
247	1029	P	46	72	BL	G,S	3.66	220
248	1033	P	42	68	BL	G,S	3.5	320
249	1034	G	38	68	BL	G,D	6.48	150
250	1035	G	38	69	BL	G,D	5.45	240
251	1036	G	38	69	BL	MX	5.25	175
252	1037	G	38	69	BRW	G,D	5.1	125
253	1038	G	38	69	BL	G,S	5.41	270
254	1039	G	38	69	BRW	G,S	6.08	235
255	1040	G	40	69	BRW	MX	6.29	195
256	1041	G	40	69	BL	G,D	5.84	245
257	1043	P	46	68	BL	G,D	4.77	150
258	1044	P	38	68	BRW	G,S	5.74	195
259	1045	G	38	68	BRW	G,S	6.12	145
260	1046	G	34	64	BRW	G,S	4.64	285
261	1047	P	34	69	BRW	G,S	2.99	320
262	1048	P	38	69	BRW	G,D	4.37	275
263	1049	G	38	64	BL	G,D	6.42	240
264	1050	G	38	68	BRW	G,S	6.65	150
265	1051	G	38	68	BL	G,D	5.7	275
266	1052	P	36	68	BRW	G,D	4.84	315
267	1054	G	38	68	BRW	G,D	5.06	220
268	1056	G	36	68	BL	G,D	5.54	225
269	1057	P	48	87	BL	G,S	2.98	70
270	1058	P	38	63	BRW	G,D	7.19	170
271	1059	P	38	63	BRW	G,D	5.56	180
272	1065	P	38	64	BRW	G,D	7.1	155
273	1066	P	32	64	BL	MX	5.52	225

No.	MLGV	Hypocotyl	50 %	80 % pod	Pod	Seed	100-seed	Yield
274	1067	G	34	64	BL	G,D	5.68	160
275	1068	G	38	69	MX	G,D	4.78	260
276	1069	P	38	69	MX	G,D	5.23	205
277	1070	G	38	69	BL	G,S	5.73	255
278	1071	G	40	69	BL	G,D	5.25	205
279	1072	G	38	69	BL	G,D	6.4	285
280	1073	G	34	69	BL	G,S	6.75	350
281	1074	P	34	58	BL	G,S	7.3	355
282	1075	P	36	58	BL	G,D	3.77	260
283	1076	P	38	69	BL	G,D	5.9	135
284	1077	P	50	87	BL	G,D	4.36	25
285	1078	P	50	87	BL	Y,D	4.94	40
286	1079	P	38	69	MX	G,D	5.17	150
287	1080	P	38	69	BL	G,D	5.65	175
288	1081	P	38	69	BRW	G,D	4.58	165
289	1082	P	40	69	MX	G,D	3.96	180
290	1083	P	42	69	BL	G,D	3.52	115
291	1084	P	50	87	BL	G,D	6.08	20
292	1085	G	38	69	BL	G,S	5.88	160
293	1086	G	38	69	BL	G,D	6.19	185
294	1103	P	50	72	BL	Y,D	6.12	70
295	1105	P	50	72	BL	G,D	5.86	215
296	1107	P	50	87	BL	G,D	5.51	30
297	1108	P	38	86	BL	G,D	5.64	60
298	1110	P	46	72	BL	G,D	6.57	70
299	1111	P	42	69	BL	G,D	4.23	150
300	1113	P	42	72	BL	G,D	6.35	95

Seed colour :
G, shiny = green, shiny
G, dull = green , dull
Y, shiny = yellow, shiny
Y, dull = yellow, dull
BR, dull = brown, dull
MX = mix

Hypocotyl colour:
G = green
P = purple
MX = mix

Pod colour :
BL = Black
BRW = Brown
MX = mix

Peer-review history:
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