



Morphological characterization of Indian mustard (*Brassica juncea*) genotypes and their application for DUS testing

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ABSTRACT

Present study on morphological characterization of Indian mustard (*Brassica juncea* (L.) Czern and Coss) genotypes/ varieties developed by CCS Haryana Agricultural University, Hisar was carried out and established distinctness among different genotypes under study. A total of 78 genotypes were grouped for several morphological descriptors. The number of lobes varies from low to medium. Stem colour varies from light green to dark green. Wide diversity has been observed for leaf length (40.2 to 63cm) and leaf breadth (18 to 27cm) also. No variability was observed for leaf division, petiole enlargement, petiole section, petiole colour, flower colour and siliqua surface outline. In majority of cases, it was observed that leaf angle was prostrate type, leaf blade shape was spatulate, leaf division dentate lyrate type, leaf apex and leaf blistering was intermediate, leaf tip and lamina attitude was straight, sparse hairs were present. Petiole length, width and thickness were intermediate type. Similar, findings were also observed for petal length, breadth, silique angle, length and width and also for pedicel and beak length. Seed colour of all the genotype was black colour except RH 401Y which was yellow in colour. Maximum genotype were of medium size (3-5g/1000 seed weight) except RH 270 (bold seed >5g/1000 seed weight). The characterization of released/pre-released genotype/varieties will provide valuable information for strengthening of future breeding programme on Indian mustard. All the 78 genotypes/ varieties are grouped into different categories on the basis of present characterization for each character and may be used as reference genotypes/varieties. Further, this characterization could be utilized for maintaining the genetic purity of a genotype as well as DUS testing becomes easy in a well characterized genotype.

Key words: *Brassica juncea*, Raya, Morphological characterization and DUS testing

Indian mustard [*Brassica juncea* (L.) Czern and Coss] is an important edible oil yielding crop grown in winter season in North-Western part of India. Haryana is an important among all the Indian mustard grown states of India. In India, it is grown on about 6 790 000 ha with annual production of 8 131 000 tonnes. Out of this, Haryana occupies 597 000 ha with annual production of 792 000 tonnes with 13.26 q/ha productivity (Anonymous 2007). In crop improvement programmes, efforts are being made to develop high yielding, disease resistant and stable cultivars. Morphological characterization of many registered genotypes or cultivars is in vogue. Further, genotype characterization of Indian mustard cultivar is also very important for the protection under Plant Variety Protection (PVP) legislation.

As DUS (distinctness, uniformity and stability) testing is essential for grant of protection to new plant varieties

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under the Plant Variety Protection and Farmers Right Act 2001 (PVP & FR Act 2001). The act has provision to compare the candidate variety with the varieties of common knowledge on a set of relevant characteristics and commonly morphological data is also required at the time of filing of application. Therefore, keeping in view the above points, present investigation was undertaken to characterize the genotypes (released/pre-released) of Indian mustard developed by CCS Haryana Agricultural University, Hisar on the basis of qualitative and quantitative morphological characters and to establish distinctness among the newly developed genotypes along with old ones.

MATERIALS AND METHODS

The experimental material comprised of 78 genotypes (released/pre-released) of Indian mustard developed and evaluated by CCS Haryana Agricultural University, Hisar, viz. RH 30, RH 270, RH 119, RH 115, RH 116, RH 202, RH 9904, RH 0004, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 506, RH 509, RH 518, RH 527, RH 555A, RH 567, RH 571, RH 401B, RH 607, RH 9304, RH 629, RH 120, RH

317, RH 345, RH 446, RH 427, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 546, RH 401Y, RH453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 630, RH 632, RH 634, RH 635, RH 636, RH 637, RH 638, RH 639, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 555, RH 552, RH 9512, RH 9615, RH 703, RH 722, RH 723, RH 724 and RH 725. The experiment was conducted in a randomized block design (RBD) with three replications at Research Farm, CCS HAU, Hisar (latitude: 29° 10' N and longitude: 75° 46' E and 215.2 m above the mean sea level, located in subtropical region of Haryana, India). Each plot consisted of 5 rows of 6 meter each with a spacing of 45 cm × 15 cm. Genotypes were evaluated for 34 traits, viz. number of leaf lobes, leaf length, leaf width, leaf angle, leaf blade shape (outer margin), leaf division (margin), leaf division (incision), leaf apex shape, leaf blade thickness, leaf blade blistering, leaf tip attitude, leaf lamina attitude, leaf colour, leaf hairiness, leaf bloom, petiole enlargement, petiole length, petiole width, petiole thickness, petiole section, petiole/midrib colour, stem colour, node colour, stem glossiness, branch angle, flower colour, petal length, petal breadth, silique angle, silique length, pedicel length, silique width, beak length and seed colour. These traits were recorded as per descriptor of IPGRI (IPGRI 1992).

The data were recorded on 10 plants in each replication of each genotype for all the characters, at specified stage of crop growth, when the character under study had full expression. All the leaf characteristics were recorded on the 8th leaf from the base. Days to flowering was recorded at 50 percent plants with at least one open flower. The entire floral characteristics were observed at 50 percent flowering. Likewise, stem, Silique and seed characteristics were recorded at 50% flowering, before maturity and after threshing, respectively.

RESULTS AND DISCUSSION

All the 78 genotypes (released/pre-released) of Indian mustard developed by CCSHAU, Hisar, after its establishment in 1960, showed considerable variation for the majority of characters under study except leaf division, petiole enlargement, petiole section, petiole colour, flower colour and silique surface out line. The characteristics of the Indian mustard genotypes under study are presented in Table 1 and frequency distribution of each descriptor of genotypes along with example genotypes is depicted in Table 2. Growth habit is determined with the help of branch angle.

Three types of growth habit (compact, semi-spreading and spreading type) are identified in present study material. Majority of genotypes were semi-spreading type. Bhargava *et al.* (1984) suggest that semi-spreading plant type contributes maximum towards seed yield production. On the basis of stem colour and node colour, genotypes have been grouped into three categories, viz. light green, green and dark green. According to number of leaf lobes genotypes were grouped

Table 1 Characterization of Indian mustard genotypes/varieties based on morphological characters

Genotype	NL	LL	LW	LA	LS	LD	LDI	LP	LK	LB	LT	LM	LC	LH	LF	PL	PW	PT	PS	PC	SC	NC	SG	BA	FC	FL	FB	SA	SL	PH	SW	BL	SC
RH 30	7	5	2	3	3	2	3	4	5	3	5	5	4	3	3	5	1	1	3	1	1	1	4	3	2	2	4	4	3	5	5	1	
RH 270	7	3	2	3	3	2	3	4	5	3	5	5	4	3	5	5	1	2	3	1	3	2	1	4	3	2	2	3	5	3	7	5	1
RH 119	7	7	3	3	4	2	3	4	5	5	5	5	4	3	5	7	3	3	3	1	3	1	2	4	3	2	2	3	5	3	7	5	1
RH 115	7	9	4	3	4	2	3	4	3	3	5	5	4	3	5	7	3	2	3	1	3	1	1	3	3	2	2	3	4	4	5	3	1
RH 116	7	7	3	3	4	2	3	4	3	3	5	5	4	3	5	7	3	2	3	1	2	1	1	2	3	2	2	3	4	3	5	5	1
RH 202	7	7	3	3	4	2	3	4	5	5	5	5	4	3	5	5	2	3	3	1	3	1	1	3	3	2	2	3	5	4	7	3	1
RH 9904	7	7	3	2	4	2	3	4	7	5	5	5	4	3	5	7	3	2	3	1	7	1	2	3	3	2	2	3	4	4	7	5	1
RH 0004	7	7	3	3	4	2	3	4	3	5	7	5	4	3	5	7	3	3	3	1	3	1	1	3	3	2	2	4	4	4	5	5	1
RH 0007	5	7	4	3	4	2	3	4	7	5	5	5	4	0	5	7	2	2	3	1	3	1	1	3	3	2	2	4	4	4	5	5	1
RH 204	7	5	3	3	4	2	3	4	5	5	5	5	3	3	3	5	2	2	3	1	3	2	1	3	3	2	2	4	4	4	5	3	1
RH 402	5	5	3	3	4	2	3	4	5	5	5	5	4	3	5	7	2	2	3	1	3	1	1	3	3	2	2	4	4	4	5	3	1
RH 8812	5	7	4	2	4	2	3	4	7	5	5	5	3	3	5	7	2	2	3	1	3	1	1	3	3	2	2	3	4	4	7	3	1
RH 406	5	7	3	3	4	2	3	4	3	5	5	5	4	3	5	7	2	2	3	1	3	2	1	2	3	2	2	4	4	4	7	5	1
RH 506	7	5	2	3	4	2	3	4	3	5	7	7	3	3	5	7	1	1	3	1	2	1	1	2	3	2	2	4	4	4	5	3	1
RH 509	7	7	3	3	4	2	3	4	5	5	5	4	3	3	5	5	2	2	3	1	3	2	1	2	3	2	2	4	4	4	5	3	1

Table 1 Contd.

Table 1 Continued

Genotype	NL	LL	LW	LA	LS	LD	LDI	LP	LK	LB	LT	LM	LC	LH	LF	PL	PW	PT	PS	PC	SC	NC	SG	BA	FC	FL	FB	SA	SL	PH	SW	BL	SC
RH 518	7	5	2	3	4	2	3	4	5	5	5	5	4	3	5	7	1	1	3	1	2	1	1	2	3	2	2	4	4	4	5	5	1
RH 527	5	5	3	3	4	2	3	4	5	5	5	5	4	3	5	7	2	2	3	1	3	2	1	3	3	2	2	4	5	4	5	3	1
RH 555A	7	7	3	3	4	2	3	4	7	5	5	5	3	3	5	7	2	1	3	1	3	1	1	2	3	2	2	3	5	7	7	5	1
RH 567	5	5	3	3	4	2	3	4	7	5	5	5	4	3	5	7	1	1	3	1	3	1	1	3	3	2	2	4	4	3	5	5	1
RH 571	7	7	2	4	4	2	3	4	5	5	5	5	2	3	5	9	2	1	3	1	3	2	1	3	3	2	2	4	4	3	5	3	1
RH 401B	7	7	4	4	4	2	3	4	7	5	5	5	3	3	5	7	2	2	3	1	3	2	1	2	3	2	2	4	3	3	7	5	1
RH 607	7	7	3	4	4	2	3	4	5	5	5	5	4	3	5	7	2	1	3	1	3	1	1	3	3	2	2	4	4	4	7	5	1
RH 9304	5	5	3	3	4	2	3	4	7	5	5	5	4	3	3	7	2	1	3	1	3	1	1	4	3	2	2	4	3	3	5	3	1
RH 629	5	7	3	3	4	2	3	4	7	5	5	5	4	3	5	9	3	1	3	1	3	1	1	3	3	2	2	4	4	3	7	5	1
RH 120	7	7	3	3	4	2	3	4	3	5	5	5	3	3	3	7	2	2	3	1	1	1	1	2	3	2	2	4	4	3	5	5	1
RH 317	7	7	4	4	4	2	3	4	7	5	5	5	4	3	3	9	3	3	3	1	1	1	1	2	3	2	2	4	5	4	7	5	1
RH 345	7	7	2	4	4	2	3	4	7	5	5	5	4	3	7	9	2	2	3	1	2	2	1	4	3	3	3	4	4	4	5	3	1
RH 446	7	5	3	4	4	2	3	4	5	5	5	5	3	3	5	7	2	2	3	1	2	2	1	3	3	3	4	4	4	4	5	5	1
RH 427	5	5	3	4	4	2	3	4	5	5	5	5	4	0	3	7	2	1	3	1	1	1	1	3	3	2	2	5	3	7	5	1	
RH 440	5	5	3	4	4	2	3	4	5	5	5	5	3	3	5	7	1	1	3	1	1	1	1	3	3	2	2	4	4	3	5	5	1
RH 441	5	5	3	4	4	2	3	4	7	5	5	5	4	3	3	7	2	1	3	1	1	1	1	4	3	2	2	4	4	4	3	5	1
RH 444	7	5	3	3	4	2	3	4	5	5	5	5	3	3	5	7	1	1	3	1	1	1	1	2	3	2	2	4	4	3	5	3	1
RH 447	5	7	3	3	4	2	3	4	7	5	5	5	4	3	3	7	2	1	3	1	1	1	1	3	3	2	2	4	4	3	3	3	1
RH 415	5	7	3	4	4	2	3	4	7	5	5	5	4	3	7	9	2	2	3	1	2	2	1	3	3	2	2	4	4	4	5	3	1
RH 525	5	5	3	4	4	2	3	4	5	5	5	5	4	3	3	7	2	2	3	1	3	3	0	4	3	2	2	4	4	3	5	3	1
RH 546	7	7	2	4	4	2	3	4	7	5	5	5	4	3	3	9	2	1	3	1	3	3	1	3	3	2	2	4	5	4	5	5	1
RH 401Y	5	5	3	4	4	2	3	4	5	5	5	5	2	3	5	7	1	2	3	1	1	1	1	2	3	2	2	4	4	3	5	5	0
RH 453	5	7	3	3	4	2	3	4	7	5	5	5	4	3	5	7	2	2	3	1	1	1	1	3	3	2	2	4	4	3	5	3	1
RH 504	7	7	3	4	4	2	3	4	7	5	5	5	4	3	5	7	2	2	3	1	1	1	1	3	3	2	2	4	4	3	5	5	1
RH 507	7	7	3	4	4	2	3	4	7	5	5	5	3	3	3	7	2	1	3	1	1	1	0	3	3	2	2	4	4	3	5	5	1
RH 508	7	7	3	4	4	2	3	4	5	5	5	5	2	3	5	7	2	2	3	1	1	1	1	3	3	2	2	4	4	4	5	3	1
RH 519	7	7	3	4	4	2	3	4	5	5	5	5	3	3	7	9	2	2	3	1	1	1	1	3	3	2	2	4	4	3	5	5	1
RH 522	7	7	3	4	4	2	3	4	5	5	5	5	2	3	5	9	2	2	3	1	2	2	1	4	3	2	2	4	4	3	5	5	1
RH 529	7	7	3	4	4	2	3	4	7	5	5	5	4	3	5	7	1	2	3	1	1	1	1	4	3	3	2	5	4	3	5	5	1
RH 533	7	7	3	3	4	2	3	4	7	5	5	5	4	3	5	9	2	2	3	1	1	1	1	4	3	2	2	4	5	3	5	5	1
RH 535	7	7	3	4	4	2	3	4	7	5	5	5	4	3	5	9	2	2	3	1	2	1	1	3	3	2	2	4	5	3	5	5	1
RH 540	7	7	2	4	4	2	3	4	7	5	5	5	3	3	5	7	2	2	3	1	2	2	1	3	3	2	2	5	5	4	5	5	1
RH 541	7	5	3	4	4	2	3	4	5	5	5	5	3	3	5	7	1	1	3	1	1	2	1	3	3	2	2	4	4	3	5	5	1
RH 604	7	7	3	4	4	2	3	4	5	5	5	5	3	3	5	7	1	1	3	1	1	1	1	3	3	2	2	4	4	3	5	3	1
RH 605	7	9	3	4	4	2	3	4	5	5	5	5	3	3	5	2	3	2	3	1	1	1	2	3	3	2	2	4	4	3	5	5	1
RH 606	7	7	3	4	4	2	3	4	5	5	5	5	3	3	5	9	2	2	3	1	1	1	1	3	3	2	2	4	4	3	5	5	1
RH 610	7	5	3	4	4	2	3	4	7	5	5	5	4	3	3	9	2	1	3	1	2	2	1	3	3	2	2	4	4	3	5	5	1
RH 616	7	7	2	3	4	2	3	4	3	5	5	5	3	3	5	9	2	2	3	1	2	2	1	4	3	2	2	4	4	4	5	5	1

Table 1 Contd.

Table 1 Continued

Genotype	NL	LL	LW	LA	LS	LD	LDI	LP	LK	LB	LT	LM	LC	LH	LF	PL	PW	PT	PS	PC	SC	NC	SG	BA	FC	FL	FB	SA	SL	PH	SW	BL	SC
RH 624	7	7	2	4	4	2	3	4	7	5	5	5	3	3	5	9	2	2	3	1	2	1	1	4	3	2	3	4	5	4	5	5	1
RH 627	7	7	2	4	4	2	3	4	5	5	5	5	4	3	5	9	1	1	3	1	2	2	1	4	3	2	2	4	4	3	5	5	1
RH 630	5	7	3	4	4	2	3	4	7	5	5	5	2	3	5	9	2	2	3	1	2	2	1	4	3	2	2	4	4	3	5	5	1
RH 632	7	7	2	4	4	2	3	4	8	7	5	5	4	3	5	9	2	2	3	1	1	1	1	3	3	2	2	4	4	3	5	5	1
RH 634	7	7	3	3	4	2	3	4	8	7	5	5	3	3	3	9	2	2	3	1	2	2	2	2	2	2	2	3	5	4	5	5	1
RH 635	5	5	3	3	4	2	3	4	5	5	5	5	3	3	5	9	2	1	3	1	2	2	1	2	3	2	2	3	4	4	5	5	1
RH 636	7	7	2	3	4	2	3	4	7	5	5	5	3	3	5	9	2	1	3	1	2	2	1	2	3	2	2	3	5	4	5	5	1
RH 637	7	7	2	4	4	2	3	4	7	3	5	5	4	3	5	9	2	1	3	1	1	1	1	2	3	2	2	3	5	4	7	5	1
RH 638	5	5	2	4	4	2	3	4	5	5	5	5	4	3	5	7	2	1	3	1	1	1	1	3	3	2	2	4	5	4	5	5	1
RH 639	7	5	2	3	4	2	3	4	5	5	5	5	3	3	5	9	2	1	3	1	2	2	1	3	3	2	2	3	5	4	5	3	1
RH 641	5	5	2	4	4	2	3	2	7	5	5	5	4	3	5	7	2	1	3	1	2	2	1	2	3	2	2	4	4	4	5	3	1
RH 642	5	7	2	4	4	2	3	4	5	5	5	5	4	3	5	7	1	1	3	1	2	2	1	3	3	2	2	4	4	3	5	3	1
RH 643	5	5	3	4	4	2	3	4	7	5	5	5	4	0	5	7	2	2	3	1	2	2	1	3	3	2	2	3	4	4	5	5	1
RH 644	5	7	2	4	4	2	3	2	7	5	5	5	3	3	5	7	1	1	3	1	2	2	1	2	3	2	2	3	4	3	5	5	1
RH 646	7	5	3	4	4	2	3	4	5	5	5	5	3	3	5	7	2	1	3	1	2	2	1	3	3	2	2	3	4	3	5	5	1
RH 647	5	5	3	3	4	2	3	4	5	5	5	5	4	3	5	7	2	1	3	1	2	2	1	4	3	2	2	4	4	3	5	3	1
RH 555	7	5	2	3	4	2	3	4	7	5	5	5	3	3	5	9	2	2	3	1	2	2	1	3	3	2	2	3	5	4	5	5	1
RH 552	5	7	3	3	4	2	3	4	7	5	5	5	3	3	5	9	1	1	3	1	2	2	1	3	3	2	2	4	5	4	5	5	1
RH 9512	7	7	3	3	4	2	3	4	5	5	5	5	2	3	5	7	2	2	3	1	2	1	2	4	3	2	2	3	5	3	5	3	1
RH 9615	7	5	2	3	4	2	3	6	7	5	5	5	4	3	5	7	2	2	3	1	1	1	1	3	3	2	2	3	5	3	5	5	1
RH 703	7	5	2	4	4	2	3	4	3	5	5	5	3	3	5	9	2	1	3	1	2	2	1	3	3	2	2	3	4	3	5	5	1
RH 722	7	7	4	4	4	2	3	2	7	5	5	5	4	3	3	7	2	2	3	1	2	2	1	3	3	2	2	3	5	3	7	5	1
RH 723	7	7	4	3	4	2	3	2	7	5	5	5	4	3	5	7	2	2	3	1	2	2	1	3	3	1	1	3	5	3	5	5	1
RH 724	7	7	3	3	4	2	3	4	7	5	5	5	4	3	5	7	2	2	3	1	2	2	1	3	3	2	1	3	5	4	7	3	1
RH 725	7	7	3	3	4	2	3	4	7	5	5	5	4	3	5	7	2	2	3	1	2	2	1	3	2	2	2	3	4	4	5	5	1

Note: State of characteristics according to national test guidance

NL: No. of leaf lobes, LL: Leaf length, LW: Leaf width, LA: Leaf angle, LS: Leaf blade shape(outer margin), LD: Leaf division(margin), LDI: Leaf division (incision), LP: Leaf apex, LK: Leaf blade thickness, LB: Leaf blade blistering, LT: Leaf tip attitude, LM: Leaf lamina attitude, LC: Leaf colour, LH: Leaf hairiness, LF: Leaf bloom, PL: Petiole length, PW: Petiole width, PT: Petiole thickness, PC: Petiole/midrib colour, SC: Stem colour, SG: Stem glossiness, BA: Branch angle, FC: Flower colour, FL: Petal length, FB: Petal breadth, SA: Siliqua angle, SL: Siliqua length, SW: Siliqua width, BL: Beak length, SC: Seed colour

Table 2 Frequency distribution and example of some important traits of 78 varieties/genotypes of *Brassica juncea*

Plant descriptors	Range in expression	Freq	Varieties/genotypes
Number of leaf lobes	5 Low	26	RH 0007, RH 402, RH 8812, RH 406, RH 527, RH 567, RH 9304, RH 629, RH 427, RH 440, RH 441, RH 447, RH 415, RH 525, RH 401Y, RH 453, RH 630, RH 635, RH 638, RH 641, RH 642, RH 643, RH 644, RH 647, RH 552
	7 Medium	52	RH 30, RH 270, RH 119, RH 115, RH 116, RH 202, RH 9904, RH 0004, RH 204, RH 506, RH 509, RH 518, RH 555A, RH 571, RH 401B, RH 607, RH 120, RH 317, RH 345, RH 446, RH 444, RH 546, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 632, RH 634, RH 636, RH 637, RH 639, RH 646, RH 555, RH 9512, RH 9615, RH 703, RH 722, RH 723, RH 724, RH 725
	9 High	0	
Leaf length	3 Short	1	RH 270
	5 Intermediate	25	RH 30, RH 204, RH 402, RH 506, RH 518, RH 527, RH 567, RH 9304, RH 446, RH 427, RH 440, RH 441, RH 444, RH 525, RH 401Y, RH 541, RH 610, RH 635, RH 636, RH 643, RH 9615 RH 703, RH 638, RH 639, RH 641, RH 646, RH 647, RH 555
	7 Long	47	RH 119, RH 116, RH 202, RH 9904, RH 0004, RH 0007, RH 8812, RH 406, RH 509, RH 555A, RH 571, RH 401B, RH 607, RH 629, RH 120, RH 317, RH 345, RH 447, RH 415, RH 546, RH 453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 604, RH 606, RH 616, RH 624, RH 627, RH 630, RH 632, RH 634, RH 637, RH 642, RH 644, RH 552, RH 9512, RH 722, RH 723, RH 724, RH 725
Leaf width	9 Very long	2	RH 115, RH 605
	2 Narrow	22	RH 30, RH 270, RH 506, RH 518, RH 571, RH 345, RH 546, RH 540, RH 616, RH 624, RH 627, RH 632, RH 644, RH 555, RH 9615, RH 703, RH 636, RH 637, RH 638, RH 639, RH 641, RH 642
	3 Intermediate	44	RH 119, RH 402, RH 204, RH 116, RH 202, RH 9904, RH 0004, RH 406, RH 509, RH 527, RH 555A, RH 567, RH 9304, RH 629, RH 120, RH 446, RH 427, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 541, RH 604, RH 605, RH 606, RH 610, RH 630, RH 634, RH 635, RH 643, RH 646, RH 647, RH 552, RH 9512, RH 724, RH 725
Leaf angle	4 Broad	7	RH 115, RH 0007, RH 8812, RH 401B, RH 317, RH 722, RH 723
	2 Open	2	RH 8812, RH 9904
	3 Semi-prostrate	37	RH 30, RH 270, RH 119, RH 115, RH 116, RH 202, RH 0004, RH 0007, RH 204, RH 402, RH 406, RH 506, RH 509, RH 518, RH 527, RH 555A, RH 567, RH 9304, RH 629, RH 120, RH 444, RH 447, RH 453, RH 533, RH 616, RH 634, RH 635, RH 636, RH 639, RH 647, RH 555, RH 552, RH 9512, RH 9615, RH 723, RH 724, RH 725
Leaf blade shape (outer margin)	4 Prostrate	39	RH 571, RH 401B, RH 607, RH 317, RH 345, RH 446, RH 427, RH 440, RH 441, RH 415, RH 525, RH 546, RH 401Y, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 610, RH 624, RH 627, RH 630, RH 632, RH 637, RH 638, RH 641, RH 642, RH 643, RH 644, RH 646, RH 703, RH 722
	2 Elliptic	0	
	3 Obovate	2	RH 270, RH 30
Leaf division (margin)	4 Spathulate	76	RH 119, RH 115, RH 116, RH 202, RH 9904, RH 0004, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 506, RH 509, RH 518, RH 527, RH 555A, RH 567, RH 571, RH 401B, RH 607, RH 9304, RH 629, RH 120, RH 317, RH 345, RH 446, RH 427, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 546, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 630, RH 632, RH 634, RH 635, RH 636, RH 637, RH 638, RH 639, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 555, RH 552, RH 9512, RH 9615, RH 703, RH 722, RH 723, RH 724, RH 725
	2 Dentate	78	RH 30, RH 270, RH 119, RH 115, RH 116, RH 202, RH 9904, RH 0004, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 506, RH 509, RH 518, RH 527, RH 555A, RH 567, RH 571, RH 401B, RH 607, RH 9304, RH 629, RH 120, RH 317, RH 345, RH 446, RH 427, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 546, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 630, RH 632, RH 634, RH 635, RH 636, RH 637, RH 638, RH 639, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 555, RH 552, RH 9512, RH 9615, RH 703, RH 722, RH 723, RH 724, RH 725

Table 2 Contd.

Table 2 Continued

Plant descriptors	Range in expression	Freq	Varieties/genotypes
Leaf division (incision)	3 Serrate	0	
	2 Sinuate	0	
	3 Lyrate	78	RH 30, RH 270, RH 119, RH 115, RH 116, RH 202, RH 9904, RH 0004, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 506, RH 509, RH 518, RH 527, RH 555A, RH 567, RH 571, RH 401B, RH 607, RH 9304, RH 629, RH 120, RH 317, RH 345, RH 446, RH 427, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 546, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 630, RH 632, RH 634, RH 635, RH 636, RH 637, RH 638, RH 639, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 555, RH 552, RH 9512, RH 9615, RH 703, RH 722, RH 723, RH 724, RH 725
Leaf apex shape	2 Acute	5	RH 519, RH 723, RH 724, RH 646, RH 641
	4 Intermediate	72	RH 30, RH 270, RH 119, RH 115, RH 116, RH 202, RH 9904, RH 0004, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 506, RH 509, RH 518, RH 527, RH 555A, RH 567, RH 571, RH 401B, RH 607, RH 9304, RH 629, RH 120, RH 317, RH 345, RH 446, RH 427, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 546, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 522, RH 529, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 630, RH 632, RH 634, RH 635, RH 636, RH 637, RH 638, RH 639, RH 642, RH 643, RH 644, RH 647, RH 555, RH 552, RH 9512, RH 703, RH 722, RH 725
	6 Rounded	1	RH 9615
Leaf blade thickness	3 thin	8	RH 115, RH 116, RH 0004, RH 406, RH 506, RH 120, RH 616, RH 703
	5 intermediate	31	RH 30, RH 270, RH 119, RH 202, RH 204, RH 402, RH 509, RH 518, RH 527, RH 571, RH 607, RH 446, RH 427, RH 440, RH 444, RH 525, RH 401Y, RH 508, RH 519, RH 522, RH 541, RH 604, RH 605, RH 627, RH 635, RH 638, RH 639, RH 642, RH 646, RH 647, RH 9512
	7 thick	37	RH 9904, RH 0007, RH 555A, RH 8812, RH 567, RH 401B, RH 9304, RH 629, RH 317, RH 345, RH 441, RH 447, RH 415, RH 546, RH 453, RH 504, RH 507, RH 529, RH 533, RH 535, RH 540, RH 606, RH 610, RH 624, RH 630, RH 636, RH 637, RH 641, RH 643, RH 644, RH 555, RH 552, RH 9615, RH 722, RH 723, RH 724, RH 725
Leaf blade blistering	8 very thick	2	RH 632, RH 634
	3 low	5	RH 30, RH 270, RH 115, RH 116, RH 637
	5 intermediate	71	RH 119, RH 202, RH 9904, RH 0004, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 506, RH 509, RH 518, RH 527, RH 555A, RH 567, RH 571, RH 401B, RH 607, RH 9304, RH 629, RH 120, RH 317, RH 345, RH 446, RH 427, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 546, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 630, RH 632, RH 636, RH 638, RH 639, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 555, RH 552, RH 9512, RH 9615, RH 703, RH 722, RH 723, RH 724, RH 725
Leaf tip attitude	7 high	2	RH 634, RH 635
	3 curving upwards	0	
	5 straight	76	RH 30, RH 270, RH 119, RH 115, RH 116, RH 202, RH 9904, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 509, RH 518, RH 527, RH 555A, RH 567, RH 571, RH 401B, RH 607, RH 9304, RH 629, RH 120, RH 317, RH 345, RH 446, RH 427, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 546, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 630, RH 632, RH 634, RH 635, RH 636, RH 637, RH 638, RH 639, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 555, RH 552, RH 9512, RH 9615, RH 703, RH 722, RH 723, RH 724, RH 725
Leaf lamina attitude	7 drooping	2	RH 0004, RH 506
	3 convex	1	RH 722,
	5 straight	76	RH 30, RH 270, RH 119, RH 115, RH 116, RH 202, RH 9904, RH 0004, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 509, RH 518, RH 527, RH 555A, RH 567, RH 571, RH 401B, RH 607, RH 9304, RH 629, RH 120, RH 317, RH 345, RH 446, RH 427, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 546, RH 401Y, RH 453, RH 504, RH 507, RH

Table 2 Contd.

Table 2 *Continued*

Plant descriptors	Range in expression	Freq	Varieties/genotypes
			508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 630, RH 632, RH 634, RH 635, RH 636, RH 637, RH 638, RH 639, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 555, RH 552, RH 9512, RH 9615, RH 703, RH 723, RH 724, RH 725
Leaf colour	7 concave-drooping	1	RH 506
	2 light green	6	RH 571, RH 401Y, RH 508, RH 522, RH 630, RH 9512
	3 green	27	RH 204, RH 8812, RH 506, RH 555A, RH 401B, RH 120, RH 446, RH 440, RH 444, RH 507, RH 519, RH 540, RH 541, RH 604, RH 605, RH 606, RH 616, RH 624, RH 634, RH 635, RH 636, RH 639, RH 644, RH 646, RH 555, RH 552, RH 703
	4 dark green	45	RH 30, RH 270, RH 119, RH 115, RH 116, RH 202, RH 9904, RH 0004, RH 0007, RH 402, RH 406, RH 509, RH 518, RH 527, RH 567, RH 607, RH 9304, RH 629, RH 317, RH 345, RH 427, RH 441, RH 447, RH 415, RH 525, RH 546, RH 453, RH 504, RH 529, RH 533, RH 535, RH 610, RH 627, RH 632, RH 637, RH 638, RH 641, RH 642, RH 643, RH 647, RH 9615, RH 722, RH 723, RH 724, RH 725
Leaf hairiness	5 purple	0	
	0 absent	3	RH 0007, RH 427, RH 643
	2 very sparse	1	RH 120
	3 sparse	74	RH 30, RH 270, RH 119, RH 115, RH 116, RH 202, RH 9904, RH 0004, RH 204, RH 402, RH 8812, RH 406, RH 506, RH 509, RH 518, RH 527, RH 555A, RH 567, RH 571, RH 401B, RH 607, RH 9304, RH 629, RH 317, RH 345, RH 446, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 546, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 630, RH 632, RH 634, RH 635, RH 636, RH 637, RH 638, RH 639, RH 641, RH 642, RH 644, RH 646, RH 647, RH 555, RH 552, RH 9512, RH 9615, RH 703, RH 722, RH 723, RH 724, RH 725
Leaf bloom	3 low	14	RH 30, RH 204, RH 9304, RH 120, RH 317, RH 427, RH 441, RH 447, RH 525, RH 546, RH 507, RH 610, RH 634, RH 722
	5 intermediate	61	RH 270, RH 119, RH 115, RH 116, RH 202, RH 9904, RH 0004, RH 0007, RH 402, RH 8812, RH 406, RH 506, RH 509, RH 518, RH 527, RH 555A, RH 567, RH 571, RH 401B, RH 607, RH 629, RH 446, RH 440, RH 444, RH 401Y, RH 453, RH 504, RH 508, RH 522, RH 529, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 616, RH 624, RH 627, RH 630, RH 632, RH 635, RH 636, RH 637, RH 638, RH 639, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 555, RH 552, RH 9512, RH 9615, RH 703, RH 723, RH 724, RH 725
Petiole enlargement	7 high	3	RH 345, RH 415, RH 519
	3 narrow	0	
	5 intermediate	78	RH 30, RH 270, RH 119, RH 115, RH 116, RH 202, RH 9904, RH 0004, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 506, RH 509, RH 518, RH 527, RH 555A, RH 567, RH 571, RH 401B, RH 607, RH 9304, RH 629, RH 120, RH 317, RH 345, RH 446, RH 427, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 546, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 630, RH 632, RH 634, RH 635, RH 636, RH 637, RH 638, RH 639, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 555, RH 552, RH 9512, RH 9615, RH 703, RH 722, RH 723, RH 724, RH 725
Petiole length	7 enlarged	0	
	5 short	5	RH 30, RH 270, RH 202, RH 509, RH 204
	7 intermediate	47	RH 119, RH 115, RH 116, RH 9904, RH 0004, RH 0007, RH 402, RH 8812, RH 406, RH 506, RH 518, RH 527, RH 555A, RH 567, RH 401B, RH 607, RH 9304, RH 120, RH 446, RH 427, RH 440, RH 441, RH 444, RH 447, RH 525, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 529, RH 540, RH 541, RH 604, RH 636, RH 637, RH 638, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 9512, RH 9615, RH 722, RH 723, RH 724, RH 725
	9 long	26	RH 571, RH 629, RH 317, RH 345, RH 415, RH 546, RH 519, RH 522, RH 533, RH 535, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 630, RH 632, RH 634, RH 635, RH 639, RH 555, RH 552, RH 703

Table 2 *Contd.*

Table 2 Continued

Plant descriptors	Range in expression	Freq	Varieties/genotypes
Petiole width	1 narrow	14	RH 30, RH 270, RH 506, RH 518, RH 567, RH 440, RH 444, RH 401Y, RH 529, RH 541, RH 627, RH 642, RH 644, RH 552
	2 intermediate	56	RH 202, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 509, RH 527, RH 555A, RH 571, RH 401B, RH 607, RH 9304, RH 120, RH 345, RH 446, RH 427, RH 441, RH 447, RH 415, RH 525, RH 546, RH 453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 533, RH 535, RH 540, RH 605, RH 606, RH 610, RH 616, RH 624, RH 630, RH 632, RH 634, RH 635, RH 636, RH 637, RH 638, RH 639, RH 641, RH 643, RH 646, RH 647, RH 555, RH 9512, RH 9615, RH 703, RH 722, RH 723, RH 724, RH 725
	3 broad	8	RH 119, RH 115, RH 116, RH 9904, RH 0004, RH 604, RH 629, RH 317
Petiole thickness	1 low	32	RH 30, RH 506, RH 518, RH 555A, RH 567, RH 571, RH 607, RH 9304, RH 629, RH 427, RH 440, RH 441, RH 444, RH 447, RH 546, RH 507, RH 541, RH 606, RH 610, RH 627, RH 635, RH 636, RH 637, RH 638, RH 639, RH 641, RH 642, RH 644, RH 646, RH 647, RH 552, RH 703
	2 medium	42	RH 270, RH 115, RH 116, RH 9904, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 509, RH 527, RH 401B, RH 120, RH 345, RH 446, RH 415, RH 525, RH 401Y, RH 453, RH 504, RH 508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 604, RH 605, RH 616, RH 624, RH 630, RH 632, RH 634, RH 643, RH 555, RH 9512, RH 9615, RH 722, RH 723, RH 724, RH 725
	3 high	4	RH 119, RH 202, RH 0004, RH 317
Petiole section	3 round	78	RH 30, RH 270, RH 119, RH 115, RH 116, RH 202, RH 9904, RH 0004, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 506, RH 509, RH 518, RH 527, RH 555A, RH 567, RH 571, RH 401B, RH 607, RH 9304, RH 629, RH 120, RH 317, RH 345, RH 446, RH 427, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 546, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 630, RH 632, RH 634, RH 635, RH 636, RH 637, RH 638, RH 639, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 555, RH 552, RH 9512, RH 9615, RH 703, RH 722, RH 723, RH 724, RH 725
	5 semi-round	0	
	1 creamy white	78	RH 30, RH 270, RH 119, RH 115, RH 116, RH 202, RH 9904, RH 0004, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 506, RH 509, RH 518, RH 527, RH 555A, RH 567, RH 571, RH 401B, RH 607, RH 9304, RH 629, RH 120, RH 317, RH 345, RH 446, RH 427, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 546, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 630, RH 632, RH 634, RH 635, RH 636, RH 637, RH 638, RH 639, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 555, RH 552, RH 9512, RH 9615, RH 703, RH 722, RH 723, RH 724, RH 725
Stem colour	2 light green	0	
	1 light green	23	RH 120, RH 317, RH 427, RH 440, RH 441, RH 444, RH 447, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 519, RH 529, RH 533, RH 541, RH 604, RH 605, RH 632, RH 637, RH 638, RH 9615
	2 green	33	RH 116, RH 406, RH 506, RH 518, RH 345, RH 446, RH 415, RH 522, RH 535, RH 540, RH 606, RH 616, RH 624, RH 627, RH 630, RH 634, RH 635, RH 636, RH 639, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 555, RH 552, RH 9512, RH 703, RH 722, RH 723, RH 724, RH 725
	3 dark green	22	RH 30, RH 270, RH 119, RH 115, RH 202, RH 0004, RH 0007, RH 204, RH 402, RH 8812, RH 509, RH 527, RH 555A, RH 567, RH 571, RH 401B, RH 607, RH 9304, RH 629, RH 525, RH 546, RH 610
Node colour	1 light green	43	RH 30, RH 119, RH 115, RH 116, RH 202, RH 9904, RH 0004, RH 0007, RH 402, RH 406, RH 506, RH 518, RH 555A, RH 567, RH 607, RH 9304, RH 629, RH 120, RH 317, RH 427, RH 440, RH 441, RH 444, RH 447, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 519, RH 529, RH 533, RH 535, RH 541, RH 604, RH 605, RH 610, RH 624, RH 632, RH 637, RH 638, RH 9512, RH 9615
	2 green	33	RH 270, RH 204, RH 8812, RH 509, RH 527, RH 571, RH 401B, RH 345, RH 446, RH 415, RH 522, RH 540, RH 606, RH 616, RH 627, RH 630, RH 634, RH 635, RH 636, RH 639, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 555, RH 552, RH 703, RH 722, RH 723, RH 724, RH 725

Table 2 Contd.

Table 2 Continued

Plant descriptors	Range in expression	Freq	Varieties/genotypes
Stem glossiness	3 dark green	2	RH 525, RH 546
	1 low	74	RH 30, RH 270, RH 115, RH 116, RH 202, RH 0004, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 506, RH 509, RH 518, RH 527, RH 555A, RH 567, RH 571, RH 401B, RH 607, RH 9304, RH 629, RH 120, RH 317, RH 345, RH 446, RH 427, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 546, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 541, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 630, RH 632, RH 635, RH 636, RH 637, RH 638, RH 639, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 555, RH 552, RH 9512, RH 9615, RH 703, RH 722, RH 723, RH 724, RH 725
Branch angle	2 intermediate	4	RH 119, RH 9904, RH 604, RH 634
	3 high	0	
	2 compact	19	RH 116, RH 8812, RH 406, RH 506, RH 509, RH 518, RH 555A, RH 401B, RH 120, RH 317, RH 444, RH 401Y, RH 634, RH 635, RH 636, RH 637, RH 641, RH 644
	3 semi-spreading	43	RH 115, RH 202, RH 9904, RH 0004, RH 0007, RH 204, RH 402, RH 527, RH 567, RH 571, RH 607, RH 629, RH 446, RH 427, RH 440, RH 447, RH 415, RH 546, RH 453, RH 504, RH 507, RH 508, RH 519, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 632, RH 638, RH 639, RH 642, RH 643, RH 646, RH 555, RH 552, RH 9615, RH 703, RH 722, RH 723, RH 724, RH 725
Flower colour	4 spreading	16	RH 30, RH 270, RH 119, RH 9304, RH 345, RH 441, RH 525, RH 522, RH 529, RH 610, RH 616, RH 624, RH 627, RH 630, RH 647, RH 9512
	0 white	0	
Petal length	3 yellow	78	RH 30, RH 270, RH 119, RH 115, RH 116, RH 202, RH 9904, RH 0004, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 506, RH 509, RH 518, RH 527, RH 555A, RH 567, RH 571, RH 401B, RH 607, RH 9304, RH 629, RH 120, RH 317, RH 345, RH 446, RH 427, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 546, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 630, RH 632, RH 634, RH 635, RH 636, RH 637, RH 638, RH 639, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 555, RH 552, RH 9512, RH 9615, RH 703, RH 722, RH 723, RH 724, RH 725
	1 short	1	RH 723
Petal breadth	2 medium	74	RH 30, RH 270, RH 119, RH 115, RH 116, RH 202, RH 9904, RH 0004, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 506, RH 509, RH 518, RH 527, RH 555A, RH 567, RH 571, RH 401B, RH 607, RH 9304, RH 629, RH 120, RH 317, RH 427, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 546, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 630, RH 632, RH 634, RH 635, RH 636, RH 637, RH 638, RH 639, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 555, RH 552, RH 9512, RH 9615, RH 703, RH 722, RH 724, RH 725
	3 low	3	RH 345, RH 446, RH 529
	1 narrow	2	RH 723, RH 724
Siliqua angle	2 medium	71	RH 30, RH 270, RH 119, RH 115, RH 116, RH 202, RH 9904, RH 0004, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 506, RH 509, RH 518, RH 527, RH 555A, RH 567, RH 571, RH 401B, RH 607, RH 9304, RH 629, RH 120, RH 317, RH 427, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 546, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 616, RH 627, RH 630, RH 632, RH 634, RH 635, RH 636, RH 637, RH 638, RH 639, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 555, RH 552, RH 9512, RH 9615, RH 703, RH 722, RH 725
	3 long	5	RH 446, RH 345, RH 453, RH 610, RH 624
	3 erect	27	RH 270, RH 119, RH 115, RH 116, RH 202, RH 9904, RH 402, RH 555A, RH 636, RH 634, RH 635, RH 637, RH 639, RH 643, RH 644, RH 646, RH 555, RH 9512, RH 9615, RH 703, RH 722, RH 723, RH 724, RH 725
	4 semi-erect	48	RH 30, RH 0004, RH 0007, RH 204, RH 8812, RH 406, RH 506, RH 509, RH 518, RH 527, RH 567, RH 571, RH 401B, RH 607, RH 9304, RH 629, RH 120, RH 317, RH 345, RH 446, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 546, RH 401Y, RH 453, RH 504,

Table 2 Contd.

Table 2 Continued

Plant descriptors	Range in expression	Freq	Varieties/genotypes
			RH 507, RH 508, RH 519, RH 522, RH 533, RH 540, RH 541, RH 604, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 630, RH 632, RH 638, RH 641, RH 642, RH 647, RH 552
Siliqua length	5 normal	3	RH 529, RH 535, RH 427
	3 short	2	RH 509, RH 9304
	4 intermediate	51	RH 30, RH 115, RH 116, RH 9904, RH 0004, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 506, RH 518, RH 567, RH 571, RH 607, RH 629, RH 120, RH 345, RH 446, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 541, RH 604, RH 605, RH 606, RH 610, RH 616, RH 627, RH 630, RH 632, RH 635, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647
	5 long	23	RH 270, RH 119, RH 202, RH 527, RH 317, RH 427, RH 546, RH 533, RH 535, RH 540, RH 624, RH 636, RH 637, RH 638, RH 639, RH 9512, RH 9615, RH 722, RH 723, RH 724, RH 634, RH 555A
Pedicel length	2 short	0	
	3 intermediate	40	RH 30, RH 270, RH 119, RH 116, RH 567, RH 571, RH 401B, RH 9304, RH 629, RH 120, RH 427, RH 440, RH 444, RH 447, RH 525, RH 401Y, RH 453, RH 504, RH 507, RH 519, RH 522, RH 529, RH 533, RH 540, RH 541, RH 604, RH 605, RH 606, RH 627, RH 630, RH 632, RH 642, RH 644, RH 646, RH 647, RH 9512, RH 9615, RH 703, RH 722, RH 723
	4 long	38	RH 115, RH 202, RH 9904, RH 0004, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 506, RH 509, RH 518, RH 527, RH 607, RH 317, RH 345, RH 446, RH 441, RH 415, RH 546, RH 508, RH 535, RH 610, RH 616, RH 624, RH 634, RH 635, RH 636, RH 637, RH 638, RH 639, RH 641, RH 643, RH 555, RH 552, RH 724, RH 725
Siliqua width	3 narrow	3	RH 441, RH 447, RH 703
	5 intermediate	58	RH 30, RH 115, RH 116, RH 0004, RH 0007, RH 204, RH 506, RH 509, RH 518, RH 527, RH 567, RH 571, RH 9304, RH 120, RH 345, RH 446, RH 440, RH 444, RH 415, RH 525, RH 546, RH 401Y, RH 453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 616, RH 624, RH 627, RH 630, RH 632, RH 634, RH 635, RH 636, RH 638, RH 639, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 555, RH 552, RH 9512, RH 9615, RH 723, RH 725
	7 broad	17	RH 270, RH 119, RH 202, RH 9904, RH 402, RH 8812, RH 406, RH 555A, RH 401B, RH 607, RH 629, RH 317, RH 427, RH 610, RH 637, RH 722, RH 724
Beak length	3 short	24	RH 115, RH 202, RH 204, RH 402, RH 506, RH 509, RH 527, RH 571, RH 9304, RH 345, RH 444, RH 447, RH 415, RH 525, RH 453, RH 508, RH 541, RH 636, RH 639, RH 641, RH 642, RH 647, RH 9512, RH 724
	5 intermediate	54	RH 30, RH 270, RH 119, RH 116, RH 9904, RH 0004, RH 0007, RH 8812, RH 406, RH 518, RH 555A, RH 567, RH 401B, RH 607, RH 629, RH 120, RH 317, RH 446, RH 427, RH 440, RH 441, RH 546, RH 401Y, RH 504, RH 507, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 604, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 630, RH 632, RH 634, RH 635, RH 637, RH 638, RH 643, RH 644, RH 646, RH 555, RH 552, RH 9615, RH 703, RH 722, RH 723, RH 725
	7 long	0	
Seed colour	0 yellow	1	RH 401Y
	1 black	77	RH 30, RH 270, RH 119, RH 115, RH 116, RH 202, RH 9904, RH 0004, RH 0007, RH 204, RH 402, RH 8812, RH 406, RH 506, RH 509, RH 518, RH 527, RH 555A, RH 567, RH 571, RH 401B, RH 607, RH 9304, RH 629, RH 120, RH 317, RH 345, RH 446, RH 427, RH 440, RH 441, RH 444, RH 447, RH 415, RH 525, RH 546, RH 453, RH 504, RH 507, RH 508, RH 519, RH 522, RH 529, RH 533, RH 535, RH 540, RH 541, RH 604, RH 605, RH 606, RH 610, RH 616, RH 624, RH 627, RH 630, RH 632, RH 634, RH 635, RH 636, RH 637, RH 638, RH 639, RH 641, RH 642, RH 643, RH 644, RH 646, RH 647, RH 555, RH 552, RH 9512, RH 9615, RH 703, RH 722, RH 723, RH 724, RH 725

into two categories i.e. low (5-6 lobes) and medium (7-8 lobes). On the basis of leaf length the genotypes were classified into four groups (short, intermediate, long and

very long), which according to leaf breadth grouped into narrow, intermediate and broad types.

In case of leaf angle, only two genotypes, viz. RH 8812

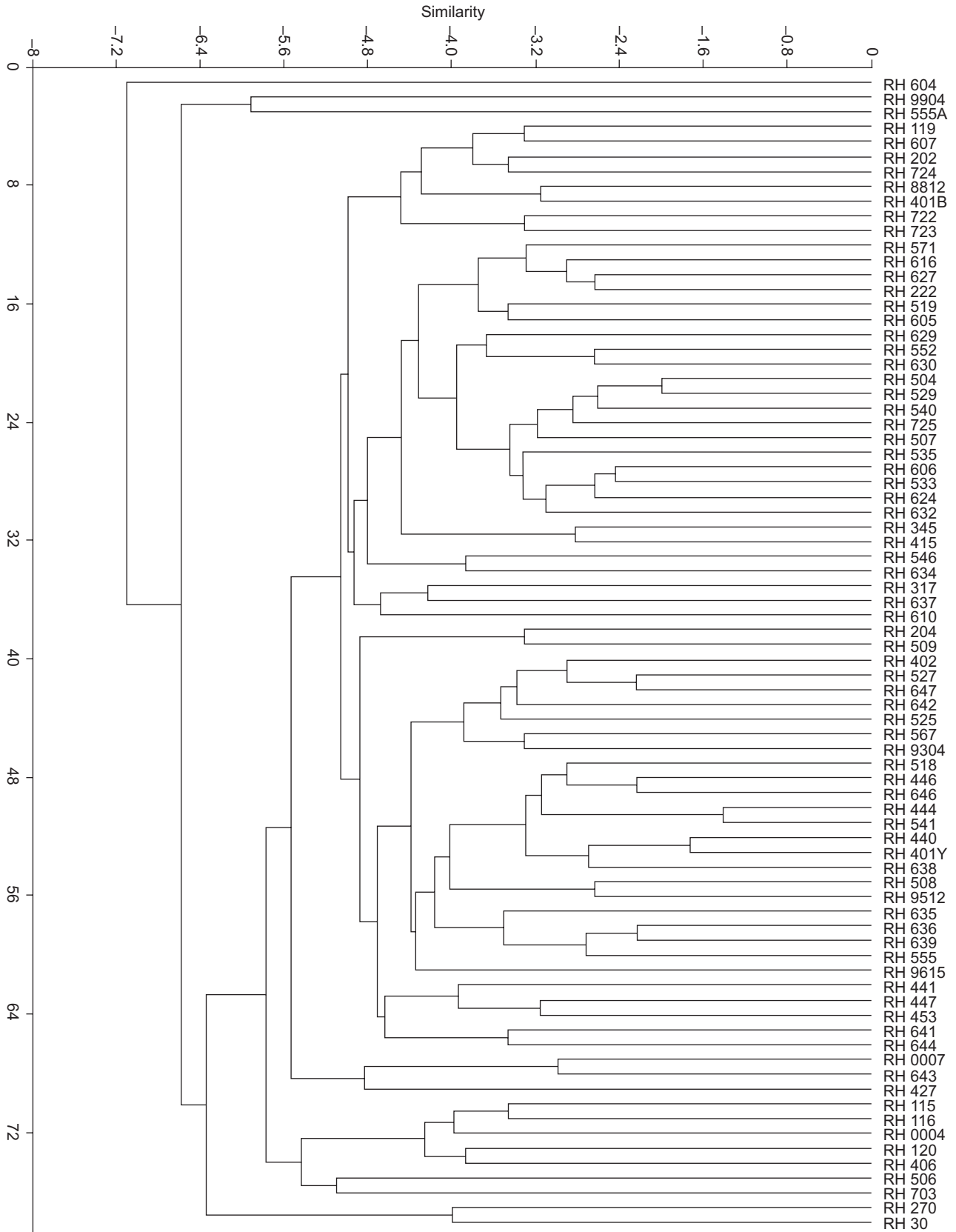


Fig 1 Dendrogram representing similarity among *Brassica juncea* genotypes based on PAST cluster analysis of Euclidean distance based on phenotypic traits

and RH 9904 were open types, while, remaining were prostrate and semi-prostrate types. Likewise, in case of leaf blade shape in outer margin only two genotypes, viz. RH 270 and RH 30 were of obovate type and rest were spatulate types. Similarly, in case of leaf apex shape, only RH 9615 have rounded type and five genotypes were with acute type and remaining genotypes were having intermediate type of leaf apex shape. On the basis of leaf blade thickness, only 2 genotypes RH 632 and RH 634 were having thickest leaf blade and among the rest of genotypes, 37 were thick, 31 intermediate and only 8 genotypes were having thin leaf blade. But on the basis of leaf blade blistering 5, 71 and 2 genotypes were having low, intermediate and high blistering, respectively. Considering leaf tip and leaf lamina attitude, out of 78 genotypes, 76 genotypes were having straight types. The leaf hairs were absent only in three genotypes (RH 0007, RH 427 and RH 643), whereas, one genotype RH 120 was having very sparse hairs and rest of genotypes were having sparse leaf hairs. All the 78 genotypes grouped on the basis of leaf bloom into three categories (low, intermediate and high) and majority of genotypes were intermediate types. In all the genotypes, leaf margins were dentate type, leaf incision was lyrate, petiole enlargement was intermediate, petiole section was rounded, petiole section was rounded type, petiole/midrib colour was creamy white, silique surface outline was undulating types and flower colour was yellow only.

According to petiole length and width, genotypes were grouped into three categories but majority of them were intermediate types. Similar findings were also observed for silique length and width. Considering silique length, 2 short, 51 intermediate and 23 long types were observed. Thurling (1991) reported that longer silique length produce a larger number of seeds per silique and it is governed by two dominant genes showing complementary interaction. On the basis of silique angle genotype were grouped into three categories viz. erect, semi-erect and normal. Only three genotypes (RH 529, RH 535 and RH 427) were normal types, 27 erect types and 48 were semi-erect types for silique angle. Pedicel length was either intermediate or long and beak length was either short or intermediate type. Only one genotype RH 401Y showed yellow seed colour and rest of genotypes depicted black colour. Breeding for triple zero (000) quality cultivars, genetic stock of yellow seed colour is required which is very rare in *Brassica juncea*. The genotype RH 401Y is having yellow seed colour so it could be utilized further for development of triple zero (000) quality cultivars. On the basis of seed size, all the genotypes were categorized into three groups, i.e. small, intermediate and bold type. Above results were supported by Pal and Singh (1990) and Katyar *et al.* (2008).

Multivariate cluster analysis of the data (all the characters) based on similarity among the genotypes/varieties gave the relative position of genotypes/varieties in each group (Fig 1). *Brassica juncea* genotypes/varieties were

broadly grouped into seven clusters representing similarity among *Brassica juncea* genotypes/varieties based on PAST cluster analysis of Euclidean distance. For further improvement genotypes/varieties may be selected on the basis of genetic divergence. Crossing between highly genetic divergent genotypes/varieties could yield better results (Singh *et al.* 2010). Therefore, genotypes/varieties may be chosen for crossing for further improvement on the basis of genetic divergence as depicted in the dendrogram. RH 30 and RH 604 were the most divergent genotypes/varieties as depicted in dendrogram. Therefore, crossing among the most divergent genotypes can achieve further improvement by getting desirable transgressive segregants.

Sufficient amount of genetic divergence should be present among the cultivated genotypes/varieties, so that further improvement could be done as per desire/requirement by using these improved genotypes/varieties. Moreover, genetic divergence among cultivated genotypes should be maintained to overcome the bad effects of monoculture. Therefore, CCS Haryana Agricultural University has developed so many genetically diverse genotypes/varieties of *Brassica juncea* which could be utilized in future to overcome any kind of biotic and abiotic stresses. All the 78 genotypes/ varieties are grouped into different categories on the basis of present characterization for each character and may be used as reference genotypes/varieties. Further, this characterization could be utilized for maintain the genetic purity of a genotype as well as DUS testing becomes easy in a well characterized genotype.

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