

# Frequency Differences of RAPD Markers in Market Classes of Melon (*Cucumis melo* L.)

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**Introduction:** The determination of variability in *Cucumis melo* L. market classes is of importance to germplasm management, plant variety protection, and in the development of breeding strategies. The genetic diversity of several commercially important melon groups (principally *Cantaloupe* and *Inodorus*) has been characterized using molecular analyses (4, 3, 6). Simple sequence repeat (SSR) and random amplified polymorphic DNA (RAPD) markers have been used to differentiate elite melon germplasm (1, 2).

Staub et al. (5) used RAPD and SSR markers to characterize genetic relationships among 46 melon accessions in two *C. melo* L. subsp. *melo* (*Cantaloupe*, *Inodorus*) and subsp. *agrestis* (*Conomon* and *Flexuosus*) groups. They examined genetic variation in accessions of diverse market classes of *Cantaloupe* (*Charentais*, *European* and *U.S. Western Shipper*, *U.S. Eastern Market*, *Galia*, and *Ogen*) and *Inodorus* [*Honeydew*, and *Casaba* (syn. Spanish; *Rochet*, *Piel de Sapo*, and *Amarillo*)]. We provide herein a summary of the variation of *Group Flexuosus* and *Conomon* accessions and the *Cantaloupe* and *Inodorus* major market class accessions examined by Staub et al. (5) grouped by RAPD marker. Such a summary will allow researchers to develop a RAPD marker array(s) to best suit their needs for strategic analyses of germplasm.

**Materials and Methods:** RAPD profiling data of *Charentais* (7), *European* (6), *U.S. Western Shipper* (3), *U.S. Eastern Market* (4), *Galia* (7), *Ogen* (6), *Honeydew* (2), *Casaba* (9), *group Conomon* (1), and *group Flexuosus* (1) accessions used by Staub et al. (5) were taken collectively. These accessions originated from seed companies (5) and the U.S. Department of Agriculture, Agricultural Research Service.

Data were provided by 57 RAPD primers (Operon and University of British Columbia (BC)) producing 118 RAPD bands (Table 1). A marker was

considered repeatable if PCR yielded a consistent result in all of three (or more) replications (putative loci; see companion paper this issue). Each RAPD marker was named by the primer designation followed by an upper case letter. Tabulations summarize the percentage of RAPD band presence within a market class or subspecies and among European and U.S. germplasm as an estimation of the polymorphism level and diversity within groups. This was calculated as number of accessions with band presence divided by the total number of accessions examined and then multiplied by 100. This calculation is hereafter referred as percent frequency.

**Results and Discussion:** The vast majority of RAPD markers were found to have a similar percent frequency in accessions in Europe and USA. Only one marker appeared completely absent in USA accessions (L18-B) and two markers were absent in European accessions (AO8-A and AS14-B) (Table 1).

All groups showed a similar average percent frequency across markers. Given the relatively large standard deviations from mean values, the variation in all the market classes examined was relatively large. The information presented regarding geographic regions may, however, depend on the germplasm array analyzed. For instance, some markers (e.g. AT5-C, AS14-A, AG15-B, BC226-B, BC407-B, and BC526-A) were present in all accessions but not in *Conomon* group. Likewise, some markers were absent in all accessions but not in a few groups (e.g. AO8-A). Some primers (e.g. C1, F1, F4, AO8, BC231, BC280, BC403, BC617, and BC663) produced products that provided minimal information for discrimination. One primer, BC252, was particularly not informative for characterizing differences in *group Inodorus*. Nevertheless, the great majority of polymorphisms was observed in this study provide for adequate variation to elucidate within and among group differences.

Table 1. Percentage of RAPD band presence within a market class or subspecies (*Inodorus*, *Cantalupensis*, *Conomon*, and *Flexuosus*) and among European and U.S. germplasm.

Primer	Inodorus			Cantalupensis								
	Casaba	Honeydew	Charentais	European Shipper	Galia	Ogen	U.S. Eastern Market	U.S. Western Shipper	Conomon	Flexuosus	Europe	USA
B12-A <sup>z</sup>	22.2	0.0	57.1	100.0	42.9	16.7	100.0	66.7	100.0	100.0	43.8	71.4
B12-B	33.3	50.0	85.7	100.0	42.9	100.0	100.0	100.0	100.0	0.0	68.8	78.6
C1-A	100.0	100.0	100.0	100.0	57.1	100.0	100.0	100.0	100.0	0.0	93.8	85.7
D7-A	44.4	0.0	0.0	0.0	85.7	100.0	0.0	0.0	0.0	0.0	40.6	21.4
D7-B	100.0	100.0	42.9	100.0	71.4	100.0	75.0	100.0	100.0	100.0	84.4	85.7
D7-C	88.9	50.0	100.0	100.0	57.1	16.7	100.0	100.0	100.0	100.0	68.8	100.0
D7-D	100.0	100.0	85.7	100.0	71.4	100.0	100.0	100.0	100.0	100.0	90.6	100.0
F1-A	100.0	100.0	100.0	83.3	100.0	100.0	100.0	66.7	100.0	100.0	96.9	92.9
F4-A	100.0	100.0	85.7	100.0	57.1	50.0	100.0	100.0	100.0	100.0	81.3	92.9
F4-B	88.9	100.0	100.0	100.0	71.4	100.0	100.0	100.0	100.0	100.0	93.8	92.9
G8-A	33.3	50.0	14.3	0.0	0.0	0.0	0.0	0.0	100.0	0.0	15.6	7.1
G8-B	100.0	100.0	85.7	100.0	71.4	16.7	100.0	66.7	0.0	100.0	78.1	78.6
I4-A	33.3	100.0	42.9	66.7	57.1	83.3	100.0	100.0	100.0	100.0	56.3	85.7
I4-B	100.0	100.0	57.1	100.0	71.4	16.7	75.0	100.0	100.0	100.0	68.8	92.9
I16-A	11.1	0.0	14.3	16.7	14.3	0.0	25.0	66.7	0.0	0.0	9.4	28.6
I16-B	100.0	50.0	85.7	100.0	100.0	100.0	100.0	100.0	0.0	100.0	93.8	92.9
L18-A	88.9	50.0	100.0	100.0	71.4	60.0	100.0	66.7	0.0	100.0	87.1	71.4
L18-B	0.0	50.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0	6.3	0.0
L18-C	66.7	100.0	100.0	83.3	42.9	66.7	50.0	100.0	0.0	100.0	71.9	71.4
N6-A	100.0	100.0	100.0	100.0	71.4	100.0	100.0	100.0	100.0	100.0	93.8	100.0
N6-B	77.8	50.0	100.0	100.0	57.1	16.7	100.0	100.0	100.0	100.0	71.9	85.7
N6-C	11.1	0.0	42.9	0.0	28.6	16.7	0.0	0.0	0.0	0.0	18.8	7.1
W7-A	88.9	100.0	100.0	66.7	42.9	0.0	100.0	100.0	100.0	100.0	65.6	85.7
W7-B	88.9	50.0	14.3	16.7	14.3	0.0	0.0	33.3	100.0	0.0	28.1	35.7
AB14-A	88.9	100.0	85.7	100.0	85.7	100.0	100.0	66.7	0.0	0.0	96.9	64.3
AB14-B	100.0	0.0	28.6	16.7	28.6	0.0	0.0	33.3	0.0	100.0	34.4	35.7
AD12-A	33.3	50.0	71.4	100.0	85.7	100.0	100.0	100.0	0.0	100.0	71.9	85.7
AD14-A	77.8	0.0	0.0	33.3	42.9	50.0	25.0	0.0	0.0	100.0	40.6	28.6
AE6-A	33.3	50.0	85.7	33.3	28.6	50.0	25.0	100.0	100.0	100.0	43.8	64.3
AE6-B	66.7	50.0	14.3	16.7	57.1	0.0	75.0	0.0	0.0	0.0	34.4	35.7
AF7-A	77.8	100.0	28.6	100.0	71.4	100.0	75.0	66.7	100.0	100.0	75.0	78.6
AF7-B	100.0	50.0	100.0	100.0	100.0	100.0	50.0	66.7	0.0	100.0	96.9	71.4
AF7-C	77.8	0.0	85.7	50.0	85.7	0.0	75.0	0.0	0.0	100.0	56.3	57.1
AF14-A	77.8	100.0	28.6	83.3	57.1	100.0	100.0	66.7	0.0	100.0	71.9	71.4
AG15-A	11.1	0.0	14.3	100.0	0.0	0.0	25.0	100.0	100.0	0.0	21.9	42.9
AG15-B	88.9	100.0	100.0	83.3	100.0	100.0	100.0	100.0	100.0	100.0	96.9	92.9
AG15-C	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0	100.0	92.9
AG15-D	100.0	50.0	28.6	33.3	14.3	0.0	0.0	66.7	0.0	100.0	37.5	42.9
AJ18-A	44.4	0.0	85.7	100.0	14.3	16.7	100.0	100.0	0.0	100.0	46.9	78.6
AJ18-B	77.8	100.0	57.1	100.0	85.7	100.0	100.0	66.7	100.0	100.0	87.5	78.6

Primer	Inodorus		Cantaloupensis									
	Casaba	Honeydew	Charentais	European Shipper	Galia	Ogen	U.S. Eastern Market	U.S. Western Shipper	Conomon	Flexuosus	Europe	USA
AK16-A	100.0	100.0	85.7	100.0	100.0	100.0	100.0	66.7	0.0	100.0	96.9	85.7
AL5-A	77.8	0.0	100.0	0.0	14.3	0.0	25.0	0.0	100.0	100.0	37.5	42.9
AM2-A	88.9	100.0	57.1	83.3	71.4	33.3	100.0	33.3	100.0	100.0	65.6	85.7
AN5-A	100.0	0.0	85.7	66.7	85.7	100.0	100.0	100.0	0.0	100.0	81.3	92.9
AN5-B	100.0	0.0	100.0	0.0	71.4	100.0	0.0	33.3	100.0	100.0	71.9	50.0
AN5-C	22.2	100.0	85.7	83.3	71.4	0.0	100.0	100.0	100.0	0.0	53.1	78.6
AO8-A	11.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.1
AO8-B	88.9	100.0	85.7	100.0	57.1	100.0	100.0	100.0	100.0	100.0	87.5	92.9
AO19-A	88.9	50.0	28.6	50.0	85.7	100.0	100.0	33.3	100.0	100.0	68.8	78.6
AO19-B	100.0	100.0	100.0	100.0	85.7	100.0	100.0	100.0	0.0	100.0	96.9	92.9
AS14-A	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0	100.0	92.9
AS14-B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	100.0	100.0	0.0	21.4
AS14-C	100.0	100.0	100.0	100.0	71.4	100.0	100.0	100.0	100.0	100.0	96.9	92.9
AS14-D	100.0	0.0	100.0	0.0	85.7	100.0	50.0	0.0	0.0	100.0	71.9	57.1
AT1-A	88.9	50.0	57.1	83.3	42.9	100.0	100.0	66.7	0.0	100.0	71.9	78.6
AT2-A	88.9	100.0	71.4	66.7	100.0	100.0	75.0	66.7	0.0	100.0	87.5	71.4
AT2-B	66.7	100.0	57.1	100.0	28.6	0.0	50.0	100.0	0.0	100.0	56.3	57.1
AT2-C	100.0	50.0	100.0	83.3	71.4	100.0	75.0	66.7	0.0	100.0	87.5	78.6
AT5-A	33.3	50.0	57.1	0.0	28.6	50.0	50.0	33.3	100.0	100.0	34.4	50.0
AT5-B	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0	100.0	92.9
AT7-A	33.3	50.0	85.7	100.0	57.1	100.0	75.0	100.0	100.0	100.0	75.0	71.4
AT15-A	55.6	100.0	14.3	83.3	71.4	100.0	100.0	100.0	0.0	100.0	68.8	71.4
AU2-A	11.1	50.0	14.3	100.0	28.6	0.0	100.0	33.3	100.0	0.0	34.4	42.9
AU2-B	66.7	100.0	100.0	0.0	28.6	16.7	100.0	0.0	100.0	100.0	50.0	57.1
AU2-C	0.0	0.0	28.6	0.0	0.0	0.0	25.0	66.7	100.0	0.0	6.3	28.6
AV11-A	77.8	50.0	100.0	33.3	100.0	100.0	25.0	0.0	0.0	100.0	78.1	50.0
AV11-B	77.8	50.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	90.6	92.9
AV11-C	66.7	100.0	85.7	100.0	85.7	100.0	100.0	0.0	0.0	100.0	87.5	64.3
AV11-D	22.2	50.0	71.4	16.7	100.0	66.7	100.0	0.0	0.0	100.0	50.0	64.3
AW10-A	100.0	100.0	85.7	100.0	85.7	100.0	100.0	100.0	0.0	100.0	93.8	92.9
AW10-B	11.1	0.0	0.0	50.0	71.4	100.0	100.0	100.0	0.0	0.0	43.8	57.1
AW10-C	66.7	100.0	85.7	100.0	28.6	0.0	50.0	100.0	100.0	100.0	59.4	71.4
AW14-A	100.0	100.0	100.0	100.0	71.4	100.0	100.0	66.7	100.0	100.0	93.8	92.9
AW14-B	33.3	0.0	57.1	0.0	14.3	0.0	0.0	0.0	100.0	0.0	18.8	21.4
AW14-C	77.8	100.0	57.1	100.0	42.9	100.0	75.0	100.0	0.0	100.0	75.0	78.6
AX16-A	100.0	50.0	85.7	83.3	83.3	100.0	75.0	100.0	100.0	100.0	87.1	92.9
AX16-B	11.1	100.0	85.7	100.0	57.1	16.7	75.0	100.0	0.0	0.0	53.1	64.3
BC226-A	44.4	100.0	71.4	66.7	50.0	100.0	100.0	66.7	100.0	100.0	71.0	71.4
BC226-B	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0	100.0	92.9
BC231-A	100.0	100.0	100.0	100.0	57.1	33.3	100.0	100.0	100.0	100.0	78.1	100.0
BC252-A	100.0	100.0	42.9	100.0	57.1	100.0	100.0	100.0	100.0	100.0	77.4	100.0
BC252-B	100.0	100.0	100.0	83.3	83.3	100.0	100.0	100.0	100.0	100.0	93.3	100.0

Primer	Inodorus		Cantaloupensis									
	Casaba	Honeydew	Charentais	European Shipper	Galia	Ogen	U.S. Eastern Market	U.S. Western Shipper	Conomon	Flexuosus	Europe	USA
BC280-A	100.0	100.0	85.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	96.9	100.0
BC280-B	100.0	100.0	100.0	100.0	85.7	100.0	100.0	100.0	100.0	0.0	96.9	92.9
BC299-A	44.4	0.0	14.3	66.7	100.0	100.0	100.0	66.7	0.0	0.0	61.3	57.1
BC318-A	100.0	100.0	100.0	100.0	85.7	100.0	100.0	66.7	0.0	100.0	96.9	85.7
BC318-B	66.7	0.0	14.3	0.0	71.4	100.0	0.0	0.0	100.0	0.0	56.3	7.1
BC388-A	77.8	100.0	14.3	100.0	71.4	100.0	75.0	100.0	100.0	100.0	71.9	85.7
BC388-B	0.0	100.0	28.6	100.0	28.6	0.0	100.0	100.0	100.0	0.0	34.4	64.3
BC403-A	100.0	100.0	100.0	100.0	85.7	100.0	100.0	100.0	100.0	100.0	96.9	100.0
BC403-B	100.0	100.0	100.0	100.0	85.7	100.0	100.0	100.0	100.0	100.0	96.9	100.0
BC407-A	100.0	100.0	100.0	100.0	100.0	83.3	100.0	100.0	100.0	100.0	96.8	100.0
BC407-B	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0	100.0	92.9
BC407-C	0.0	0.0	14.3	0.0	0.0	0.0	0.0	33.3	100.0	0.0	3.2	14.3
BC469-A	66.7	0.0	42.9	83.3	57.1	100.0	75.0	100.0	0.0	0.0	62.5	71.4
BC469-B	100.0	100.0	28.6	100.0	57.1	100.0	75.0	100.0	0.0	100.0	78.1	78.6
BC469-C	22.2	0.0	42.9	0.0	14.3	0.0	50.0	0.0	100.0	0.0	12.5	35.7
BC526-A	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0	100.0	100.0	92.9
BC526-B	66.7	0.0	14.3	16.7	57.1	83.3	75.0	33.3	0.0	100.0	40.6	64.3
BC526-C	55.6	100.0	85.7	100.0	42.9	33.3	50.0	66.7	0.0	100.0	62.5	64.3
BC551-A	88.9	100.0	100.0	100.0	85.7	100.0	100.0	100.0	100.0	100.0	93.8	100.0
BC551-B	100.0	50.0	57.1	100.0	42.9	0.0	75.0	100.0	100.0	100.0	59.4	85.7
BC605-A	11.1	50.0	14.3	33.3	42.9	0.0	0.0	0.0	0.0	0.0	18.8	14.3
BC617-A	100.0	100.0	100.0	100.0	80.0	100.0	100.0	100.0	100.0	100.0	100.0	92.9
BC627-A	11.1	0.0	0.0	50.0	14.3	0.0	25.0	100.0	100.0	0.0	12.5	42.9
BC628-A	88.9	50.0	71.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	90.6	92.9
BC628-A	11.1	100.0	42.9	16.7	14.3	100.0	75.0	0.0	0.0	100.0	37.5	42.9
BC628-B	44.4	50.0	85.7	100.0	42.9	100.0	25.0	100.0	100.0	100.0	71.9	64.3
BC642-A	100.0	100.0	85.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	96.8	100.0
BC642-A	44.4	100.0	42.9	66.7	71.4	83.3	100.0	66.7	0.0	100.0	59.4	78.6
BC642-B	44.4	100.0	42.9	66.7	33.3	100.0	100.0	66.7	0.0	100.0	61.3	64.3
BC646-A	44.4	50.0	42.9	33.3	66.7	50.0	100.0	0.0	0.0	0.0	41.9	57.1
BC646-A	100.0	100.0	100.0	100.0	83.3	100.0	100.0	100.0	0.0	100.0	96.8	92.9
BC652-A	100.0	100.0	28.6	100.0	85.7	100.0	100.0	66.7	100.0	100.0	84.4	85.7
BC652-B	44.4	100.0	14.3	100.0	71.4	100.0	100.0	66.7	0.0	100.0	65.6	71.4
BC654-A	88.9	50.0	57.1	66.7	42.9	100.0	0.0	66.7	0.0	100.0	71.9	42.9
BC654-B	88.9	50.0	71.4	0.0	42.9	0.0	25.0	0.0	0.0	0.0	40.6	35.7
BC663	100.0	50.0	100.0	100.0	100.0	100.0	100.0	66.7	100.0	100.0	96.9	92.9
Average	70.0	65.7	65.4	71.3	61.6	66.5	73.9	68.9	52.5	74.6	66.6	69.7
Std. dev.	33.5	40.1	34.6	38.3	30.2	43.1	36.6	38.2	50.1	43.7	28.1	26.3

<sup>2</sup>Band labeled as primer designation is followed by a upper case letter.

This primer set was chosen by Staub et al. (5) from a survey of 1,500 primers for its ability to detect polymorphism in an array of diverse melon germplasm. These primers are likely to maximize the detection of genetic variation in other arrays of melon germplasm. Information given herein allows strategic primer selection for development of RAPD marker test arrays in melon.

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