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About the Institute

The Hunt Institute for Botanical Documentation, a research division of Carnegie Mellon University, specializes in the history of botany and all aspects of plant science and serves the international scientific community through research and documentation. To this end, the Institute acquires and maintains authoritative collections of books, plant images, manuscripts, portraits and data files, and provides publications and other modes of information service. The Institute meets the reference needs of botanists, biologists, historians, conservationists, librarians, bibliographers and the public at large, especially those concerned with any aspect of the North American flora.

Hunt Institute was dedicated in 1961 as the Rachel McMasters Miller Hunt Botanical Library, an international center for bibliographical research and service in the interests of botany and horticulture, as well as a center for the study of all aspects of the history of the plant sciences. By 1971 the Library's activities had so diversified that the name was changed to Hunt Institute for Botanical Documentation. Growth in collections and research projects led to the establishment of four programmatic departments: Archives, Art, Bibliography and the Library.

USED by Jancey 1964-65

Manihot--List of Characters and Attributes

Label Name M Specimen No. 822

Collector and No. Rodgers 430

1. Distribution (geography)

U. S. (W. Tex., N. M., Ariz., Calif.)

U. S. (E. Tex., La., Miss., Ala., Fla.)

Mexico

Central America

West Indies

Caribbean Colombia & Venezuela

Amazonian Venezuela, Colombia, Guianas, Brazil & Peru

N. E. Brazil

S. Brazil, Uruguay, Argentina

Paraguay and Bolivia

Peru, Ecuador and W. Colombia

2. Plant habit

MS decumbent, prostrate, reclining, or caespitose shrub

erect shrub or small tree (below 4 m.)

tree (above 4 m.)

3. Lenticels

circular

elongate

elongate and branched

4. Leaf lobe or leaflet number--range and mode (3) all

5. Division of leaf lamina

lobed

compound

6. Leaf lobe or leaflet apex
long acuminate
acute
abruptly acuminate
rounded
emarginate
7. Total length of median rib (cm.) 14.5
8. Length of median lobe (cm.) 13.5
9. Ratio of 7:8 .93
10. Lobe width--measured as widest point on median lobe
or leaflet (cm.) 6.5
11. Lobe or leaflet shape
ratio 7:10 .45
12. Insertion of petiole on lamina
 at base of lamina
peltate
13. Abaxial surface of leaf
tomentose
sparsely haired
 glabrous
14. Abaxial surface of leaf
pulverulent
 smooth
15. Abaxial surface of leaf--wax granules
uniform ←
patterned around stomata
16. Petiole length (cm.) 9.0
17. Ratio of 7:16 .62

18. Stipules

minute (< 2 mm. long) deciduous except in youngest shoots

~~pergled (> 2 mm. long)~~ persisting at least until
maturity of leaf

19. Stipule length (mm.) 15

20. Stipule shape

linear

lanceolate

ovate

21. Stipule margins

entire

laciniate

INFLORESCENCE

22. Hairiness of inflorescence

tomentose

pubescent

glabrous

23. Bracts--length 14 mm

24. Bracts--shape

linear

lanceolate

ovate

25. Bract margin

entire

laciniate

26. Bracteoles--insertion

at base of pedicel

half way up pedicel

immediately below disc

27. Bracteole length (mm.) 7
28. Bracteole shape
 ~~linear~~
 lanceolate
 ovate
29. Length of pedicel (cm.) 0.5

STAMINATE FLOWER

30. Bud shape
 conical
 ~~waisted~~
31. Tepal lobes
 ~~thickened on one edge~~
 uniform
32. Length of tepal lobes (cm.) 1.1
33. Total length of tepal (cm.) 1.7
34. Filament length -- long set (cm.) .8
35. Filament length--short set (cm.) .4
36. Ratio of 35:36 1.5
37. Presence or absence of hairs on filaments
 present
 ~~absent or sparse~~
38. Lobing of gland at base of staminate flower
 non-lobed
 moderately lobed
 ~~deeply lobed~~
39. Color of staminate tepal
 red
 yellow
 ~~green~~

SEED CHARACTERS

40. Seed length (cm.)

1.0

41. Seed breadth (cm.)

.8

42. Ratio 40:41

.8

43. Caruncle on seed

present

absent

44. Size of caruncle (width in mm.)

3.3

enlarged

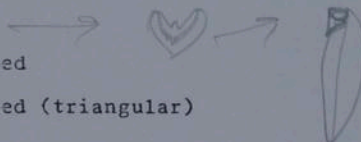
minute

45. Caruncle shape

distinctly lobed

moderately lobed (triangular)

not lobed



45. Caruncle shape

distinctly lobed

moderately lobed (triangular)

not lobed

STEM CHARACTERISTICS

A. Color of Stem

- 101 Silver
- 102 Silver-brown
- 103 Brown
- 104 Yellow

B. Internal Stem Color

- 105 Dark yellow 2.5Y 7/10
- 106 Very yellow 2.5Y 9/9
- 107 Yellow, light yellow 5Y 9/9
- 108 Cream, light cream 10Y 9/9
- 109 Light green yellow, 2.5GY 9/8
yellow green
- 110 Light green, green 7.5GY 9/8
- 111 Green white, white 2.5GY 9/3

xxxxxxxxxxxx

C. Branching of Plant

- 112 Branched at top
- 113 Branched at 3/4
- 114 Branched at top and 3/4
- 115 Branched at 1/2
- 116 Branched at top and 1/2
- 117 Branched at 3/4 and 1/2
- 118 Branched at top, 3/4 and 1/2
- 119 Branched at 1/4
- 120 Branched at top and 1/4
- 121 Branched at 3/4 and 1/4
- 122 Branched at top, 3/4 and 1/4
- 123 Branched at 1/2 and 1/4
- 124 Branched at top, 1/2 and 1/4
- 125 Branched at 3/4, 1/2 and 1/4
- 126 Branched at top, 3/4, 1/2 and 1/4
- 127 Unbranched

see attached matrix

LEAF CHARACTERISTICS

D. Color of Young Foliage

- 128 Reddish blue
- 129 Reddish green
- 130 Bluish green
- 131 Green

E. Petiole Color

- 132 Red
- 133 Reddish green
- 134 Greenish red
- 135 Green

F. Leaf Lobe Shape

- 136 Obovate
- 137 Pandurate
- 138 Linear

G. No. Lobes/Leaf

- 139 5 lobes
- 140 6 lobes
- 141 7 lobes
- 142 8 lobes
- 143 9 lobes

h. Median Lobe Length

- 144 Less than 14 cm.
- 145 14-17 cm.
- 146 Greater than 17 cm.

ROOT CHARACTERISTICS

I. External Color

- 147 Light brown yellow 5Y
- 148 Brown, dark brown, reddish brown 2.5Y - 7.5YR
- 149 Light brown, tan, light tan 10YR - 5YR
- 150 Pinkish-brown, pinkish tan 7.5YR - 5 YR
- 151 Pinkish white, light pink, pink 10R - 2.5RP

J. Cortex Color

- 152 Very white, white, cream white white
- 153 Very light cream, light cream, cream cream
- 154 Cream yellow, light yellow 7.5Y 9/8
- 155 Yellow 5Y 8/12
- 156 Blank
- 157 Pinkish yellow 7.5YR 9/4
- 158 Pinkish white 2.5YR 9/3

K. Surface of Root

- 159 Smooth
- 160 Rough

L. Subepidermis Color

- 161 White
- 162 White yellow, light yellow brown
~~Light yellow-brown, white,~~
yellow ~~high~~
- 163 Light brown
- 164 Pink

M. Stom Characteristics, Storey length

- 165 4-8 cm.
- 166 9-12 cm.
- 167 13-18 cm.
- 168 19-20 cm.
- 169 21-28 cm.

N. Scar Prominence

- 170 Smooth
- 201 Slightly raised
- 202 Moderately pronounced
- 203 Very large

C Branching of plant.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

1	1															
2	875	2														
3	500	500	3													
4	750	875	350	4												
5	450	400	550	450	5											
6	350	450	750	500	916	6										
7	250	200	500	150	500	350	7									
8	625	750	250	875	150	350	100	8								
9	320	300	833	300	916	666	350	350	9							
10	150	450	666	400	666	916	300	450	916	10						
11	200	150	500	100	400	300	875	150	450	450	11					
12	250	350	583	500	666	833	250	500	750	916	350	12				
13	150	100	350	150	450	300	750	200	450	400	875	500	13			
14	100	150	250	200	300	350	625	250	350	450	750	500	875	14		
15	0.25	0.33	250	0.50	300	350	250	100	350	400	333	450	416	50	15	
16	500	417	450	333	400	350	100	250	350	150	0.50	250	0.33	0.25	0	16

1

9

2

10

3

11

4

12

5

13

6

14

7

15

8

16

MORPHOLOGIC CHARACTERS EMPLOYED IN THE TAXIMETRIC STUDY OF MANIHOT
(MEXICO AND CENTRAL AMERICA)

- K₁ Outline of median lobe
1. Linear
 2. Truncate
 3. Ovate-oblong
 4. Ovate-oblong/pandurate
 5. Pandurate: basal portion rounded
 6. Pandurate: basal portion produced with rounded apex
 7. Pandurate: basal portion produced with pointed apex
 8. Hastate/gladiate
- K₂ Leaf venation
1. Camptodromous
 2. Craspedodromous
- K₃ Basal lobule apex termination
1. Spine
 2. No spine
 3. No basal lobule
- K₄ Shape of basal lobule apex of craspedodromous leaves
1. Acuminate
 2. Cuspidate/dilated
 3. Camptodromous leaves
- K₅ To be deleted
- K₆ Number of lobes/comparative size
1. 3
 2. 3 + occasionally 2 smaller
 3. 3 + 2 smaller
 4. 3 + 2 slightly smaller
 5. 3 + 2 smaller + often 2 minute
 6. 3 + 2 slightly smaller + 2 smaller
 7. 5 - 9 or more

- K₇ Size of the median lobe
1. Length < 2.5 cm: width 1 - 2.5 cm
 2. Length 2.5 - 5 cm: width 1 - 2.5 cm
 3. Length 5 - 12 cm: width 1 - 2.5 cm
 4. Length 5 - 12 cm: width 1 - 2.5 cm: deep indentation
 5. Length 5 - 12 cm: width >2.5 cm
 6. Length 5 - 12 cm: width >2.5 cm: shallow indentation
 7. Length 5 - 12 cm: width >2.5 cm: deep indentation
 8. Length >12 cm: width 1 - 2.5 cm
 9. Length >12 cm: width >2.5 cm
 10. Length >12 cm: width 1 - 2.5 cm: indentation
 11. Length 5 - 12 cm: width < 1 cm.
- K₈ Lowest lobe shape
1. Same as median lobe
 2. Slightly smaller than median lobe: non-symmetric
 3. About 1/2 as long as median lobe: apex cuspidate
 4. About 1/4 as long as median lobe: apex attenuate
 5. About 1/2 as long as median lobe: S-shaped
 6. Variable: usually same as median lobe
 7. About 1/4 as long as median lobe: apex rounded
- K₉ Base of lamina
1. Non-peltate
 2. Non-peltate rudimentary lobes present
 3. Narrowly peltate: 0.2 - 0.5 cm
 4. Widely peltate: >0.5 cm
 5. Very narrowly peltate 0.2 cm
- K₁₀ Lamina at base of median lobe sinus
1. Lamina disjunct: leaf appears compound
 2. Lamina connected: narrow < 0.5 cm
 3. Lamina connected: variable narrow-wide
 4. Lamina connected: wide > 0.5 cm
- K₁₁ Width of median lobe base
1. Only midrib with practically no lamina
 2. <0.25
 3. Variable narrow - wide
 4. >0.25 cm

K₁₂ Shape of sinus (see picture)

1. - 8.

K₁₃ Shape of primary constriction of median lobe

1. Mostly long: incised
2. Mostly long: cleft
3. Mostly short: occasionally long/sinuate
4. Mostly short: occasionally long/entire
5. Short
6. No constriction: ovate-oblong
7. No constriction: hastate-gladiate

K₁₄ Position and shape of secondary constrictions of median lobe

1. Within/below the primary constriction usually deep
2. Within the primary constriction rarely below
3. Rarely present but within the primary constriction
4. No secondary constriction: pandurate
5. No secondary constriction: ovate-oblong
6. One constriction only below the basal lobule
7. Several shallow constrictions above the basal lobule
8. No constriction: gladiate
9. No secondary constriction: hastate
- A. A very shallow constriction near apex

K₁₅ Shape of median lobe apex (see picture)

1 - F(15)

K₁₆ Abaxial surface wax pattern of leaf

1. Smooth
2. Stubby
3. Farinose

K₁₇ Petiole length

1. Short < 5 cm
2. Medium 5 - 15 cm
3. Long > 15 cm

K₁₈ Arrangement of leaves

1. Very close rosette-like
2. Wider spaced

K₁₉ Plant growth habit

1. Vine
2. Decumbent shrub
3. Spindling shrub
4. Erect small shrub
5. Erect tall shrub - erect low tree
6. Low spreading tree - spreading shrub
7. Crookedly branching low tree
8. Tall woody tree
9. Erect shrub of variable height
- A. Weak stemmed trailing shrub
- B. Erect woody shrub

K₂₀ Inflorescence

1. Solitary flower, rarely 2
2. Raceme: subspicate/corymbose
3. Raceme: subspicate
4. Raceme: variable of less than medium length
5. Panicle of medium size
6. Panicle: long with much branching
7. Raceme: long

K₂₁ Position of female flowers in the inflorescence

1. Diverse
2. Only above the lower half of rachis on long pedicels
3. Only at the base of inflorescence
4. Flower solitary

K₂₂ Open flower reflexion

1. Reflexed
2. Strait

K₂₃ Nature of bracteoles

- | | |
|-------------------|-----------------------------------|
| 1. Foliaceous | 3. No bracteole: flowers solitary |
| 2. Non-foliaceous | 4. Semi-foliaceous |

- K₂₄ Color of bracteole in herbarium material
1. Purplish
 2. Greenish white
 3. No bracteole
- K₂₅ Nature of bractlets
1. Foliaceous
 2. Non-foliaceous
 3. Absent
- K₂₆ Color of mature flower tepal
1. Greenish yellow
 2. Purplish streaked
- K₂₇ Shape of mature male bud
1. Long almost tubular
 2. Almost tubular with a tendency toward inflation at the bottom
 3. Distinctly constricted in the middle and inflated at the bottom
 4. Cone shaped
 5. Campanulate
 6. Auriculate
- K₂₈ Length of male tepal
1. > 2 cm
 2. < 2 cm
- K₂₉ Position of fruits in the fruit cluster
1. Basal
 2. Above the lower half of the rachis
 3. Base up to apex of inflorescence
 4. Single fruit connected with the stem directly
- K₃₀ Color of flower buds
1. Greenish yellow
 2. Purplish

- K₃₁ Size of mature fruit
1. Small: height < 1.25 cm
 2. Medium: height 1.25 - 1.75 cm
 3. Large: height 1.75 - 2.5 cm
 4. Very large: height > 2.5 cm
 5. Variable: 1.25 - 2.5

- K₃₂ Fruit surface
1. Without ribs
 2. Perceptibly ribbed
 3. Prominently ribbed

- K₃₃ Fruit apex
1. Without point
 2. Slightly pointed
 3. Prominently pointed

- K₃₄ Seed size and shape
1. Small round: < 1 cm
 2. Small oblong: < 1 cm
 3. Medium round: 1 - 1.5 cm
 4. Medium oblong: 1 - 1.5 cm
 5. Large round: 1.5 - 2 cm
 6. Large oblong: 1.5 - 2 cm
 7. Very large > 2 cm

- K₃₅ Pubescence of young stem
1. Pubescent
 2. Sparsely pubescent
 3. Glabrous

- K₃₆ Pubescence of mature stem
1. Pubescent
 2. Sparsely pubescent
 3. Glabrous

- K₃₇ Tepal pubescence
1. Pubescent
 2. Glabrous
 3. Sparsely pubescent
- K₃₈ Pubescence of bractlets
1. Pubescent
 2. Glabrous
 3. Sparsely pubescent
- K₃₉ Root
1. Tuberous
 2. Non-tuberous
- K₄₀ Color of mature stem
1. Reddish brown
 2. Dark reddish brown
 3. Brownish grey
 4. Greenish brown
 5. Silvery grey
- K₄₁ Position of bractlets in the pedicel
1. At halfway
 2. Near the base
 3. One near base; one at halfway
 4. Near top
 5. No consistent pattern
- K₄₂ Bracteole margin
1. Smooth
 2. Serrate
 3. No bracteole
- K₄₃ Pubescence of ovary
1. Pubescent
 2. Glabrous
- K₄₄ Pubescence of pedicel
1. Pubescent
 2. Glabrous

K₄₅ Rogers et Appan identification

1. M. pauciflora T. S. Brandegee
2. M. Walkerae Croizat
3. M. microcarpa M. Arg.
4. M. microcarpa ssp. parvicocca Stat. Nov.
5. M. mexicana I. M. Johnston
6. M. angustiloba [Torr.] M. Arg.
7. New Tamaulipas species
8. M. chlorosticta Standley & Goldman
9. New Oaxaca species
10. M. ludibunda Croizat
11. M. Davisiae Croizat
12. M. aesculifolia [H.B.K.] Pohl
13. M. aesculifolia ssp. intermedia Stat. Nov.
14. M. esculenta Crantz
15. M. auriculata McVaugh
16. M. isoloba Standley
17. M. caudata Greenman
18. M. michaelis McVaugh
19. M. foetida [H.B.K.] Pohl
20. M. Pringlei Watson
21. M. tomatophylla Standley

Manihot esculenta characters - January, 1967

STEM CHARACTERS, Nos. 1, 2, 14, 15

K₁ Color of Stem

1. Silver N = 6
2. Silver-brown K = 1
3. 0
4. 0
5. Brown
6. Yellow

K₂ Branching of Plant

1. One branch at top or no branches
2. One or two branches but not 1 branch if at top
3. More than 2 branches

LEAF CHARACTERS, Nos. 3-10

K₃ Leaf Lobe Shape

1. Obovate
2. Linear

K₄ Number of Lobes of Leaf

1. 3 or 4 lobes
2. 3, 4 or 5 lobes
3. 5 or 6 lobes
4. 4, 5 or 6 lobes
5. 7 or 8 lobes
6. 9 or 10 lobes

K₅ Length of Median Lobe

1. Less than 14 cm
2. 14-17 cm
3. Greater than 17 cm

K₆ Width of Median Lobe (widest point)

1. Narrow (1.5 cm - 2.4 cm)
2. Medium (2.6 cm - 4.8 cm)
3. Broad (5.0 →)

K₇ Sinuosity of Lobes of Linear Leaves

1. Pandurate
2. Some sinuosity
3. Simple (not sinuous)
4. Logical (obovate)

K₈ Sinuosity of Lobes of Obovate Leaves

1. Pandurate
2. Some sinuosity
3. Simple (not sinuous)
4. Logical (linear)

K₉ Color of Young Foliage

1. Reddish-blue
2. Bluish-green
3. Green

K₁₀ Petiole Color

1. Red
2. Green-red
3. Red-green
4. Green

	R	GR	RG	G
R	1			
GR	75	1		
RG	25	75	1	
G	0	25	75	1

ROOT CHARACTERS, Nos. 11, 12, 13

K₁₁ External Color of Root

1. Light brown-yellow
2. Brown, dark brown, reddish brown
3. Light brown, tan, light tan
4. Pinkish brown, pinkish tan
5. Pinkish white, light pink, pink

K₁₂ Cortex (root) color

1. White to cream
2. White to cream with pink
3. Cream-yellow to yellow
4. Cream-yellow to yellow with pink

	1	2	3	4
1	1			
2	75	1		
3	0	0	1	
4	0	0	75	1

K₁₃ Surface of Root

1. Smooth
2. Rough

STEM CHARACTERS, Nos. 1, 2, 14, 15

K₁₄ Nature of Scars on Stem

1. Smooth
2. Slightly raised N = 4
3. Moderately raised K = 1
4. Very large

K₁₅ Storey Length

1. 4-8 cm
2. 9-20 cm
3. 21-28 cm

Manihot esculenta, characters - January, 1967

STEM CHARACTERS, Nos. 1, 2; 14, 15

K₁ Color of Stem

1. Silver N = 6
2. Silver-brown K = 1
3. 0
4. 0
5. Brown
6. Yellow

K₂ Branching of Plant

1. One branch at top or no branches
2. One or two branches but not 1 branch if at top
3. More than 2 branches

LEAF CHARACTERISTICS, Nos. 3-10

K₃ Leaf Lobe Shape

1. Obovate
2. Linear

K₄ Number of Lobes of Leaf

1. 3 or 4 lobes
2. 3, 4 or 5 lobes
3. 5 or 6 lobes
4. 4, 5 or 6 lobes
5. 7 or 8 lobes
6. 9 or 10 lobes

K₅ Length of Median Lobe

1. Less than 14 cm
2. 14-17 cm
3. Greater than 17 cm

K₆ Width of Median Lobe (widest point)

1. Narrow (1.5 cm - 2.4 cm)
2. Medium (2.6 cm - 4.8 cm)
3. Broad (5.0 →)

K₇ Sinuosity of Lobes of Linear Leaves

1. Pandurate
2. Some sinuosity
3. Simple (not sinuous)
4. Logical (obovate)

K₈ Sinuosity of Lobes of Obovate Leaves

1. Pandurate
2. Some sinuosity
3. Simple (not sinuous)
4. Logical (linear)

K₉ Color of Young Foliage

1. Reddish-blue
2. Bluish-green
3. Green

K₁₀ Petiole Color

1. Red
2. Green-red
3. Red-green
4. Green

	R	GR	RG	G
R	1			
GR	75	1		
RG	25	75	1	
G	0	25	75	1

ROOT CHARACTERISTICS, Nos. 11, 12, 13

K₁₁ External Color of Root

1. Light brown-yellow
2. Brown, Dark brown, reddish brown
3. Light brown, tan, light tan
4. Pinkish brown, pinkish tan
5. Pinkish white, light pink, pink

K₁₂ Cortex (root) color

1. White to cream
2. White to cream with pink
3. Cream-yellow to yellow
4. Cream-yellow to yellow with pink

	1	2	3	4
1	1			
2	75	1		
3	0	0	1	
4	0	0	75	1

K₁₃ Surface of Root

1. Smooth
2. Rough

STEM CHARACTERISTICS, Nos. 1, 2; 14, 15K₁₄ Nature of Scars on Stem

1. Smooth
2. Slightly raised N = 4
3. Moderately raised K = 1
4. Very large

K₁₅ Storey Length

1. 4-8 cm
2. 9-20 cm
3. 21-28 cm

Manihot esculenta

October 12, 1966

- K₁ Color of stem
1. silver
 2. silver-brown
 - 3 = 0
 - 4 = 0
 5. brown
 6. yellow
- K = 1
- K₂ Leaf lobe shape
1. obovate
 2. linear
- K₃ Number of lobes of leaf
1. 3 or 4 lobes
 2. 5 or 6 lobes
 3. 7 or 8 lobes
 4. 9 or 10 lobes
- K₄ Branching of plant
- See matrix
- K₅ Nature of scars on stem
1. slightly raised
 2. moderately raised
 3. smooth
 4. very large
- N = 2
K = 1
- K₆ Storey length of stems
1. 4-8 cm
 2. 9-20 cm
 3. 21-28 cm
- K₇ Length of median lobe
1. less than 14 cm
 2. 14-17 cm
 3. greater than 17 cm

K₄ Branching of Plant

1. Branched at top
2. Branched at $3/4$
3. Branched at top and $3/4$
4. Branched at $1/2$
5. Branched at top and $1/2$
6. Branched at $3/4$ and $1/2$
7. Branched at top, $3/4$ and $1/2$
8. Branched at $1/4$
9. Branched at top and $1/4$
- A 10. Branched at $3/4$ and $1/4$
- B 11. Branched at top, $3/4$ and $1/4$
- C 12. Branched at $1/2$ and $1/4$
- D 13. Branched at top, $1/2$ and $1/4$
- E 14. Branched at $3/4$, $1/2$ and $1/4$
- F 15. Branched at top, $3/4$, $1/2$ and $1/4$
- G 16. Unbranched

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1															
2	875	2														
3	500	500	3													
4	750	875	350	4												
5	450	400	550	450	5											
6	350	450	750	500	916	6										
7	250	200	500	150	500	350	7									
8	625	750	250	875	150	350	100	8								
9	350	300	833	300	916	666	350	350	9							
10	150	450	666	400	666	916	300	450	916	10						
11	200	150	500	100	400	300	875	150	450	450	11					
12	250	350	583	500	666	833	250	500	750	916	350	12				
13	150	100	350	150	450	300	750	200	450	400	875	500	13			
14	100	150	250	200	300	350	625	250	350	450	750	500	875	14		
15	.025	.033	250	050	300	350	250	100	350	400	333	450	416	50	15	
16	500	417	450	333	400	350	100	250	350	150	050	250	033	.025	0	16

K₈ Senuosity of lobes of linear leaves

1. pandurate
2. some senuosity
3. simple (not senuous)
4. logical (obovate)

K₉ Senuosity of lobes of obovate leaves

1. pandurate
2. some senuosity
3. simple (not senuous)
4. logical (linear)

K₁₀ External color of root

1. light brown, yellow
2. brown, dark brown, reddish brown
3. light brown, tan, light tan
4. pinkish brown, pinkish tan
5. pinkish white, light pink, pink

Manihot esculenta, characters added 6/14/66K₁₁ Color of young foliage

1. reddish-blue
2. zero
3. reddish-green
4. bluish-green
5. zero
6. green

N = 6

K = 1

K₁₂ Petiole color

1. red
2. zero
3. reddish-green
4. greenish-red
5. zero
6. green

	R	RG	GR	G
R	1			
RG	3	1		
GR	75	6	1	
G	0	75	3	1

K₁₃ Cortex (root) color

1. white to cream
2. cream-yellow to yellow
3. pinkish tinge

K₁₄ Width of median lobe (widest point)

1. narrow (1.5 cm - 2.4 cm.)
2. medium (2.6 cm - 4.8 cm.)
3. broad (5.0 →)

Manihot esculenta

October 12, 1966

- K_1 Color of stem
1. silver
 2. silver-brown
 - 3 = 0
 - 4 = 0
 5. brown
 6. yellow
- $K = 1$
- K_2 Leaf lobe shape
1. obovate
 2. linear
- K_3 Number of lobes of leaf
1. 3 or 4 lobes
 2. 5 or 6 lobes
 3. 7 or 8 lobes
 4. 9 or 10 lobes
- K_4 Branching of plant
- See matrix
- K_5 Nature of scars on stem
1. slightly raised
 2. moderately raised
 3. smooth
 4. very large
- $N = 2$
 $K = 1$
- K_6 Storey length of stems
1. 4-8 cm
 2. 9-20 cm
 3. 21-28 cm
- K_7 Length of median lobe
1. less than 14 cm
 2. 14-17 cm
 3. greater than 17 cm

K₄ Branching of Plant

1. Branched at top
2. Branched at $3/4$
3. Branched at top and $3/4$
4. Branched at $1/2$
5. Branched at top and $1/2$
6. Branched at $3/4$ and $1/2$
7. Branched at top, $3/4$ and $1/2$
8. Branched at $1/4$
9. Branched at top and $1/4$
- A 10. Branched at $3/4$ and $1/4$
- B 11. Branched at top, $3/4$ and $1/4$
- C 12. Branched at $1/2$ and $1/4$
- D 13. Branched at top, $1/2$ and $1/4$
- E 14. Branched at $3/4$, $1/2$ and $1/4$
- F 15. Branched at top, $3/4$, $1/2$ and $1/4$
- G 16. Unbranched

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1															
2	875	2														
3	500	500	3													
4	750	875	350	4												
5	450	400	550	450	5											
6	350	450	750	500	916	6										
7	250	200	500	150	500	350	7									
8	625	750	250	875	150	350	100	8								
9	350	300	833	300	916	666	350	350	9							
10	150	450	666	400	666	916	300	450	916	10						
11	200	150	500	100	400	300	875	150	450	450	11					
12	250	350	583	500	666	833	250	500	750	916	350	12				
13	150	100	350	150	450	300	750	200	450	400	875	500	13			
14	100	150	250	200	300	350	625	250	350	450	750	500	875	14		
15	.025	.033	250	050	300	350	250	100	350	400	333	450	416	50	15	
16	500	417	450	333	400	350	100	250	350	150	050	250	033	.025	0	16

K₈ Senuosity of lobes of linear leaves

1. pandurate
2. some senuosity
3. simple (not senuous)
4. logical (obovate)

K₉ Senuosity of lobes of obovate leaves

1. pandurate
2. some senuosity
3. simple (not senuous)
4. logical (linear)

K₁₀ External color of root

1. light brown, yellow
2. brown, dark brown, reddish brown
3. light brown, tan, light tan
4. pinkish brown, pinkish tan
5. pinkish white, light pink, pink

Manihot esculenta, characters added 6/14/66K₁₁ Color of young foliage

1. reddish-blue
2. zero
3. reddish-green
4. bluish-green
5. zero
6. green

N = 6

K = 1

K₁₂ Petiole color

1. red
2. zero
3. reddish-green
4. greenish-red
5. zero
6. green

	R	RG	GR	G
R	1			
RG	3	1		
GR	75	6	1	
G	0	75	3	1

K₁₃ Cortex (root) color

1. white to cream
2. cream-yellow to yellow
3. pinkish tinge

K₁₄ Width of median lobe (widest point)

1. narrow (1.5 cm - 2.4 cm.)
2. medium (2.6 cm - 4.8 cm.)
3. broad (5.0 →)

April 27, 1966

List of Characters and Attributes
Used in First Run of M. esculenta

- New Old
- 1 = 1 = A Color of Stem
1. Silver
 2. Silver brown
 3. Brown
 4. Yellow
- 2 = 4 = D Color of Young Foliage
1. Reddish blue
 2. Reddish green
 3. Bluish green
 4. Green
- 3 = 5 = E Petiole Color
1. Red
 2. Reddish green
 3. Greenish red
 4. Green
- 4 = 6 = F Leaf Lobe Shape
1. Obovate
 2. Obovate pandurate
 3. Linear (? , HSF)
 4. Linear pandurate
- 5 = 7 = G Number Lobes/Leaf
- | | |
|----------|----------|
| 1. Five | 5. Nine |
| 2. Six | 6. Four |
| 3. Seven | 7. Three |
| 4. Eight | |
- 6 = 8 = H Median Lobe Length
1. Less than 14 cm
 2. 14-17 cm
 3. Greater than 17 cm
- 7 = 11 = K Surface of Root
1. Smooth
 2. Rough
- 8 = 13 = N Scar Prominence
1. Smooth
 2. Slightly raised
 3. Moderately pronounced
 4. Very large

First Run April 1966

M. esculenta Coding Sheets

	<u>1</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>11</u>	<u>13</u>
118	2	4	4	1	2	3	2	2
120	1	4	1	1	3	3	1	2
122	1	4	1	1	2	3	1	2
125	1	3	1	1	1	3	1	4
130	1	3	4	2	3	3	1	4
132	1	4	4	2	5	2	1	3
137	1	4	4	3	1	1	1	1
139	2	4	4	1	1	1	2	2
140	4	1	1	1	3	1	2	1
143	1	4	4	3	1	1	2	2
145	3	4	4	1	3	2	2	1
146	1	3	4	1	3	2	1	3
150	1	2	1	1	3	3	1	1
154	1	4	4	3	3	3	2	2
156	3	4	2	1	3	2	2	2
160	1	1	1	1	3	1	1	1
164	3	4	4	1	3	3	2	2
167	2	2	1	1	3	1	2	1
171	1	4	4	1	3	3	1	1
172	1	4	4	1	3	2	1	1
179	3	1	4	1	3	2	2	1
182	2	1	4	1	1	1	2	2
192	1	4	1	1	1	1	1	1
196	2	1	2	1	3	2	2	3

	1	4	5	6	7	8	11	13
200	1	4	1	1	1	1	1	2
222	3	3	3	1	3	3	2	2
225	1	3	4	3	3	2	1	2
237	1	1	1	1	3	3	1	1
239	3	1	4	1	3	3	2	2
241	3	1	2	1	3	3	2	2
245	1	3	1	1	3	3	1	2
248	3	3	4	1	1	2	1	1
250	1	1	1	1	1	2	2	3
252	3	1	1	1	2	2	2	2
255	4	4	4	1	3	3	2	2
322	3	4	3	1	3	2	2	3
333	3	4	3	2	2	2	2	3
374	3	4	3	1	3	2	2	3
376	3	4	3	1	3	3	2	3
390	3	4	2	1	7	1	2	1
419	3	4	3	3	1	2	2	3
420	4	4	3	1	3	2	2	3
432	1	2	1	3	5	3	1	2
434	3	4	1	1	1	2	2	4
446	4	4	3	1	1	2	2	4
454	1	4	3	3	3	3	1	3
456	1	3	1	3	3	3	1	3
463	4	3	3	1	2	2	2	2
476	3	4	2	1	1	1	2	2
478	4	4	3	3	1	3	2	2

April 22, 1966

LIST OF CHARACTERS USED IN FIRST RUN OF M. ESCULENTA

1. Color of stem
2. Color of young foliage
3. Petiole color
4. Leaf lobe shape
5. Number of lobes
6. Median lobe length
7. Surface of root
8. Scar prominence

April 20, 1966

Number to be run of M. esculenta first run

Jamaica	Costa Rica	Brazil	Bolivia	Peru
118	222	322	420	454
120	225	333	419	456
122	237	374	432	463
125	239	376	434	476
130	241	390	446	478
132	245			
137	248			
139	250			
140	252			
143	255			
145				
146				
150				
154				
156				
160				
164				
167				
171				
172				
179				
182				
192				
196				
200				

RECORDING FOR IBM CARDS

I. Stem character

- A. Color of stem
1. S Silver
 2. SB Interm. silver-brown
 3. B Brown
 4. Y Yellow
- B. Internal stem color
1. DY Dark yellow
 2. Y Yellow
 3. LY Light yellow
 4. YG Yellowish green
 5. C Cream
 6. LC Light cream
 7. W White
 8. LGY Light greenish yellow
 9. LG Light green
 10. VY Very yellow
 11. GW Greenish white
- C. Branching of plant
1. 0
 2. $\frac{1}{2}$
 3. $\frac{2}{3}$
 4. $\frac{3}{4}$
 5. top

II. Deaf characters

- A. Color of young foliage
1. RB Reddish blue
 2. RG Reddish green
 3. BG Bluish green
 4. G Green
- B. Petiole color
1. R Red
 2. RG Reddish green
 3. GR Greenish red
 4. G Green
- C. Leaf lobe shape
1. Obovate
 2. Pandunate (fiddle-shaped)
 3. Linear
- D. No. lobes/leaf
1. 5
 2. 6
 3. 7
 4. 8
 5. 9
- E. Median lobe length
1. Less than 14 cm.
 2. 14-17 cm.
 3. Greater than 17 cm.

III. Root characters

- A. Color, external
1. DB Dark brown
 2. B Brown
 3. LB Light brown
 4. PB Pinkish brown
 5. T Tan
 6. PT Pinkish tan
 7. LT Light tan
 8. PW Pinkish white
 9. LP Light pink
 10. P Pink
 11. RB Reddish brown
 12. LBY Light brownish yellow
- B. Internal, cortex color
1. VW Very white
 2. W White
 3. VLC Very light cream
 4. LC Light cream
 5. C Cream
 6. CY Cream yellow
 7. LY Light yellow
 8. Y Yellow
 9. PY Pinkish yellow
 10. PW Pinkish white
 11. CW Cream white
- C. Surface of root
1. Smooth
 2. Rough
- D. Subepidermis color
1. P Pink
 2. W White
 3. WY Whitish yellow
 4. LYB Light yellowish brown
 5. LB Light brown

Spec No	Stem Length	Scar Prominence				SP No	Stem No	Scar Prominence						
		1	2	3	4			1	2	3	4			
210						258	15-3	X						
11						59	10-2							X
12	28-5	X												
13	25-5	X				260	11-2						X	
14	24-5		X			61	14-3			X				
15	23-5		X			62	9-2			X				
16	21-5	X				63	14-3			X				
17	24-5	X				64	14-3		X					
18	20-4			X		65	19-4	X						
19	10-2		X			66	12-2				X			
						67	11-2			X				
220	20-4	X				68	16-3			X				
21	23-5		X			69	11-2			X				
22	26-4		X											
23	25-5	X				270	12-2					X		
24	10-2		X			71	8-1						X	
25	11-2		X			72	11-2			X				
26	24-5		X			73	7-1					X		
27	13-2		X			74	10-2			X				
28						75	13-3	X						
29	10-2	X				76	13-3		X					
						77	11-2			X				
230	4-1		X			78	12-2	X						
31	15-3		X			79	11-2			X				
32	23-5	X												
33						280	15-3			X				
34	12-2			X		81	13-3			X				
35						82	15-3			X				
36	20-4		X			83	12-2			X				
37	16-3	X				84	9-2					X		
38	21-5	X				85	11-2			X				
39	18-3		X			86	11-2					X		
240	10-2	X				87	11-2			X				
41	20-4		X			88	9-2			X				
42	16-3	X				89								
43	22-5		X			290	13-3			X				
44	23-5		X			91	13-3			X				
45	14-3		X			92	12-2			X				
46	10-2	X				93	15-3			X				
47	11-2		X			94	12-2			X				
48	8-1			X		95	12-2			X				
49	14-3		X			96	6-1					X		
250	12-2			X		97	10-2			X				
51	11-2		X			98	11-2						X	
52	15-3		X			99	11-2	X						
53	6-1	X												
54	20-4		X			300	11-2			X				
55	9-2		X			01	13-3			X				
56	10-2		X			02	17-3			X				
57	12-2		X			03	10-2					X		

Specimen No.	9 10 11			12 13 14		15 16 17		
	1	2	3	4	5	2	3	4
230	X					X		
231		X				X		
232				X	X			
233								
234	X						X	
235								
236			X			X		
237	X			X				
238			X	X				
239	X					X		
240	X			X				
241			X			X		
242	X			X				
243			X			X		
244			X			X		
245	X					X		
246	X			X				
247	X					X		
248	X					X		
249	X					X		
250	X					X		
251	X					X		
252	X					X		
253	X			X				
254			X			X		
255	X					X		
256	X					X		
257	X					X		
258	X	X		X				
259	X							X
260	X						X	
261	X					X		
262	X					X		
263	X					X		
264	X			X				
265		X	X					
266	X					X		
267	X					X		
268	X					X		

Specimen No.	9 10 11			12 13 14		15 16 17		
	1	2	3	4	5	2	3	4
269	X						X	
270	X						X	
271	X							X
272	X						X	
273	X						X	X
274	X						X	
275	X				X			
276	X						X	
277	X						X	
278	X				X			
279	X						X	
280	X						X	
281	X						X	
282	X						X	
283	X						X	
284	X						X	X
285	X						X	
286	X						X	X
287	X						X	
288	X						X	
289								
290	X						X	
291	X						X	
292	X						X	
293	X						X	
294	X						X	
295	X						X	
296	X						X	X
297	X						X	
298	X							X
299	X				X			
300	X						X	
301	X						X	
302	X						X	
303	X							X

Specimen No.	209				212				215				Specimen No.	209				212				215			
	1	2	3	4	1	2	3	4	1	2	3	4		1	2	3	4	1	2	3	4	1	2	3	4
152		X											191		X								X		
153	X								X				192		X					X					
154	X								X				193		X								X		
155			X										194		X					X					
156		X										X	195		X								X		
157	X								X				196		X								X		
158		X										X	197		X								X		
159		X										X	198	X									X		
160			X						X				199		X								X		
161		X										X	200		X								X		
162				X					X				201			X		X							
163					X				X				202		X								X		
164		X										X	203		X								X		
165	X								X				204			X		X					X		
166		X										X	205			X							X		
167			X						X				206				X						X		
168		X										X	207		X			X					X		
169			X									X	208		X								X		
170		X										X	209		X			X					X		
171		X							X				210		X								X		
172		X							X				211		X			X					X		
173		X										X	212				X	X							
174		X										X	213				X	X							
175		X										X	214				X						X		
176		X										X	215				X						X		
177			X									X	216				X	X							
178		X							X				217				X	X							
179		X							X				218				X						X		
180				X					X			X	219		X								X		
181				X					X				220			X		X							
182				X					X				221				X						X		
183	X											X	222			X							X		
184		X										X	223				X	X							
185		X							X				224		X								X		
186			X						X				225		X								X		
187		X							X				226				X						X		
188		X							X				227		X								X		
189		X							X				228												
190		X										X	229		X			X							

Spec No	Stem Length	Scar Prominence			
		1	2	3	4
120	9-2		X		
21	14-3			X	
22	20-4		X		
23	10-2				X
24	14-3			X	X
25	10-2			X	X
26	9-2			X	
27	7-1				X
28	7-1			X	
29	11-2			X	
130	14-3				X
31	12-2		X		
32	11-2			X	
33	14-3		X		
34	10-2		X		
35	9-2	X			
36	14-3			X	
37	18-3	X			
38	21-5	X			
39	22-5		X		
140	15-3	X			
41	9-2	X			
42	16-3	X			
43	13-3		X		
44	15-3		X		
45	20-4	X			
46	10-2			X	
47	17-3	X			
48	11-2	X			
49	10-2	X			
150	18-3	X			
51	10-2		X		
52	9-2	X			
53	7-1		X		
54	8-1		X		
55	17-3				X
56	12-2		X		
57	12-2	X			
58	11-2			X	
59	12-2		X		
160	16-3	X			
61	12-2		X		
62	20-4	X			
63	23-5	X			
64	10-2		X		
65	7-1	X			
66	11-2			X	

Spec No	Stem Length (cm)	Scar Prominence			
		1	2	3	4
167	18-3	X			
68	10-2		X		
69	17-3				X
170	12-2				X
71	12-2	X			
72	10-2	X			
73	12-2			X	
74	15-3			X	
75	18-3			X	
76	15-3				X
77	20-4			X	
78	15-3	X			
79	18-3	X			
180	22-5	X			
81	22-5	X			
82	21-5			X	
83	7-1				X
84	12-2			X	
85	18-3			X	
86	20-4			X	
87	14-3			X	
88	18-3	X			
89	12-2			X	
190	11-2				X
91	16-3			X	
92	14-3	X			
93	17-3			X	
94	12-2	X			
95	17-3				X
96	13-3				X
97	13-3			X	
98	7-1			X	
99	18-3			X	
200	17-3			X	
01	20-4	X			
02	13-3			X	
03	11-2				X
04	19-4	X			
05	20-4			X	
06	24-5			X	
07	9-2	X			
08	12-2			X	
09	17-3	X			

Spec. No.	Measurement Category	Story Length - cm.				LF Scar	Pronounced
		1	2	3	4		
73	14-3						
74	10-2				X		
75	7-1				X		
76	14-3				X		
77	12-2					X	
78	9-2					X	
80	13-3				X		
81	17-3		X				
82	10-2		X				
83	17-3		X				
84	16-3		X				
85	10-2						X
86	10-2		X				
88	7-1					X	
90	11-2				X		
91	12-2		X				
92	11-2				X		
93	12-2				X		
94	8-1						X
95	12-2		X				
96	11-2						X
97	12-2		X				
98	10-2						X
99	13-3				X		
100	20-4		X				
101	15-3		X				
02	8-1				X		
03	12-2				X		
04	8-1				X		
05	13-3		X				
06	9-2				X		
07	10-2						X
08	12-2				X		
09	12-2						X
110	16-3				X		
11	6-1		X				
12	10-2		X				
13	12-2		X				
14	14-3				X		
15	15-3				X		X
16	13-3		X				
17	7-1				X		
18	14-3				X		