DANSEED SYMPOSIUM 2015

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VARIETAL IDENTIFICATION IN TOMATO

A perspective from Multispectral imaging

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OUTLINE

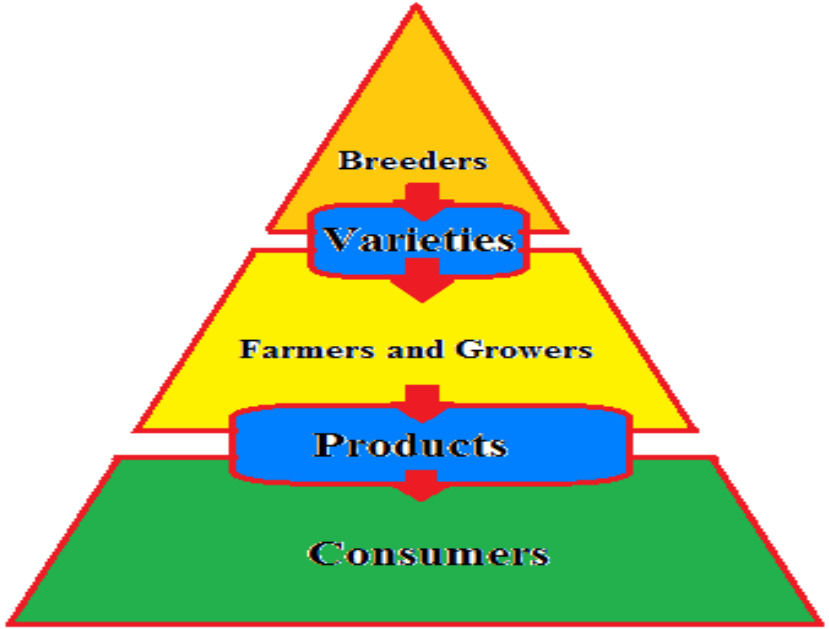
- Background
- Objectives
- Materials & Methods
- Results
- Perspective and Summary

VARIETY

A plant grouping within single botanical taxon of the lowest rank

- Expression of characteristics
- Distinguishable
- Stable

WHY VARIETAL IDENTIFICATION??



Yield; Resistance; Crop Quality; Input efficiency

Higher Profitability; Access to new markets; reduced Labor costs; Crop diversity

Low cost; High quality & nutritious; good shelf-life; diverse range of products, Choice of products and source

WHY VARIETAL IDENTIFICATION??

Varietal Identification/discrimination

- Registration and certification
- Seed producers/processors/traders
- Adulteration issues (PBRs)

- Plant Breeder Rights- UPOV, TRIPS or *sui generis* of TRIPS

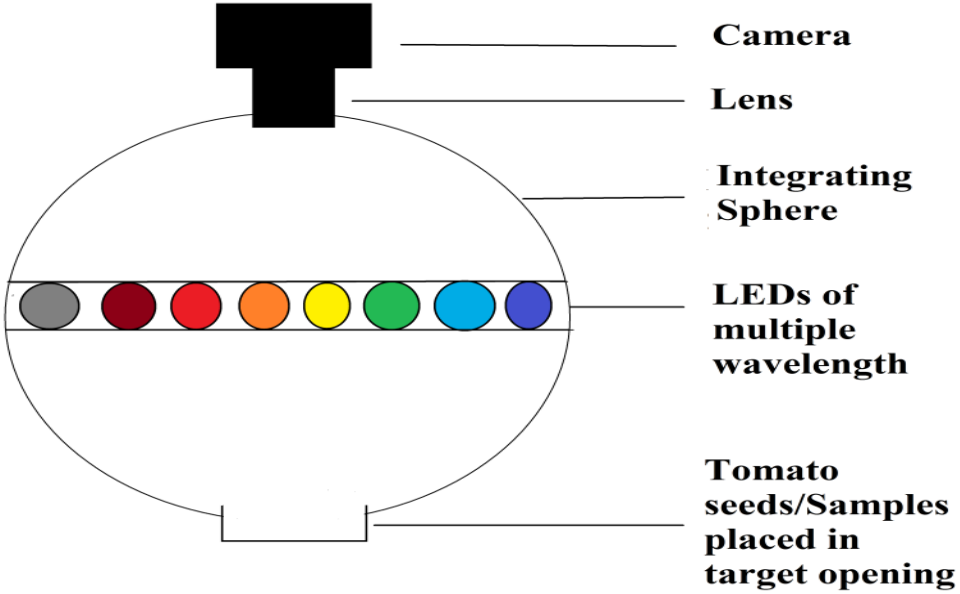
WHY VARIETAL IDENTIFICATION IN TOMATO??

- Tomato - *Solanum lycopersicum* L.
- No. 1 vegetable crop- economically
- Rich in Antioxidants- Vitamin C, Lycopene and β-carotene
- Intensive breeding efforts- high demand and health benefits
- Large number of tomato varieties worldwide than any other vegetable crops (Foolad and Panthee 2012)

NON DESTRUCTIVE TECHNOLOGIES

- Visible/near infrared spectra
  - Use of leaf for discrimination in tomato
  - Use of tomato fruits for transgenic discrimination
- Hyperspectral imaging – maize and wheat
- Multispectral Imaging
  - prediction of unripe tomatoes
- Varietal identification of tomatoes using seeds???

VIDEOMETERLAB INSTRUMENT

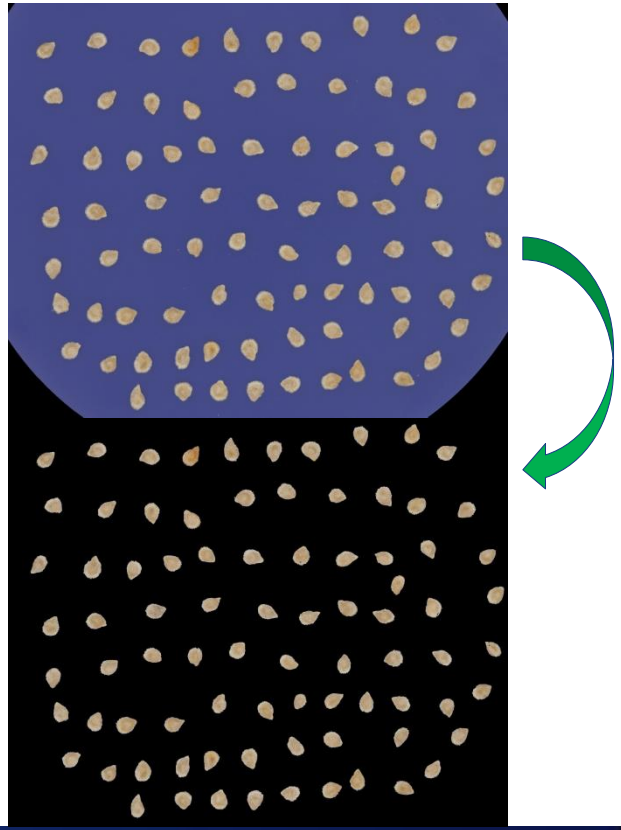


MATERIALS

Cultivar/Accession	Number of Seed Used			Seed Source	Remarks
	Calibration	Prediction	Total		
Sample set One					
HRD 1	55	-	55	NARC, Nepal	Breeding Material
HRD 17	50	-	50	NARC, Nepal	Breeding Material
HRD 1 × HRD 17	50	-	50	Crossed at Semi-field	HRD 1 as female parent
HRD 17 × HRD 1	50	-	50	Crossed at Semi-field	HRD 17 as female parent
Sample set Two					
BL 410	176	50	226	SEAN Seed, Nepal	Released Cultivar
Care Nepal	225	66	291	Seed retailer, Nepal	Farmer's variety
Chiuri	133	76	209	Seed retailer, Nepal	Farmer's variety
CL (also known as NCL)	134	95	229	SEAN Seed, Nepal	Released Cultivar
Doti Local	171	65	236	SEAN Seed, Nepal	Farmer's variety
HRD 1	134	54	188	NARC, Nepal	Breeding Material
HRD 17	192	91	283	NARC, Nepal	Breeding Material
Lapsigede	172	71	243	SEAN seed, Nepal	Released Cultivar
Monprecus	160	58	218	VDD, Nepal	Released Cultivar
Pusa Ruby	137	59	196	NARC, Nepal	Released Cultivar
T 9	169	37	206	SEAN Seed, Nepal	Breeding Material

IMAGE ACQUISITION

- Image acquisition – VideometerLab equipment
- Tomato seeds were placed on image “VM Blue” disc
- 19 wavelengths (375, 405, 435, 450, 470, 505, 525, 570, 590, 630, 645, 660, 700, 780, 850, 870, 890, 940 and 970 nm)
- Masking- default “Blue Background” option



ANALYSIS- VIDEOMETERLAB

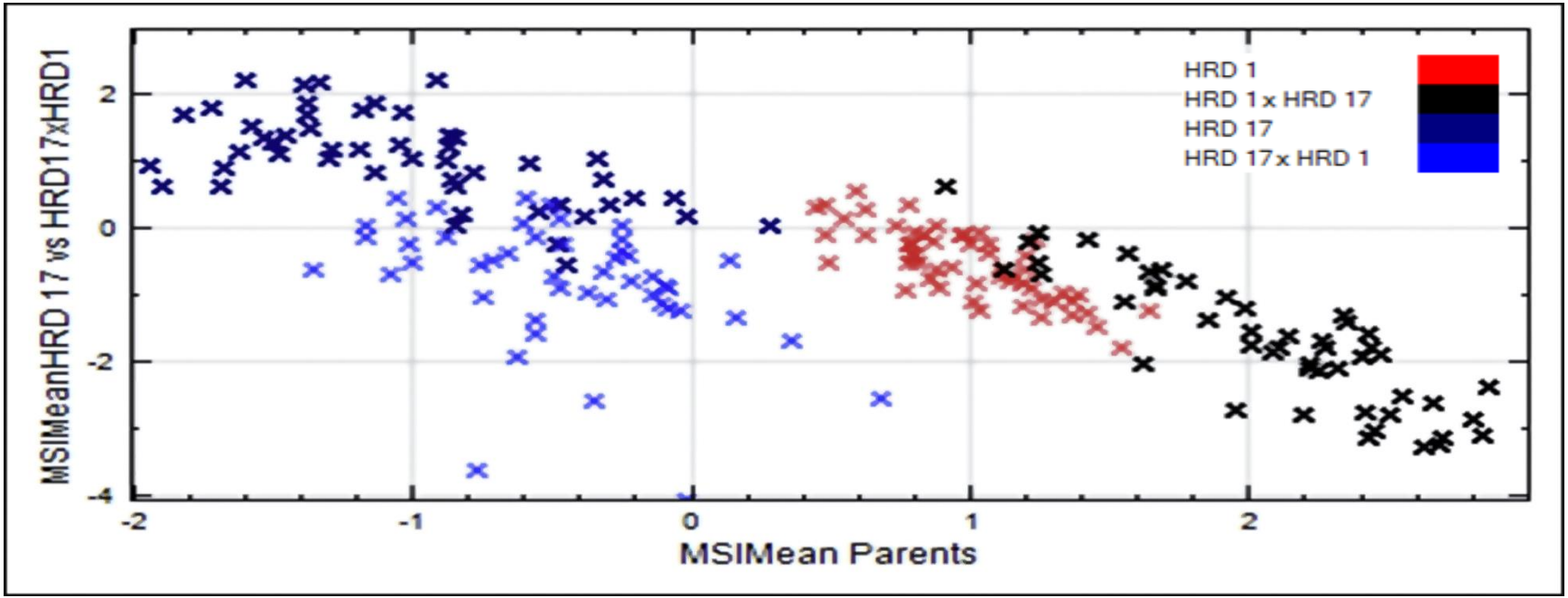
- nCDA MSI transformations- specific pairwise & all cultivars
- Shape – Area, length, roundness, width
- Color – CIELab L^*, CIELab a^*, CIELab b^*, intensity, saturation, and hue
- RegionMSImean –nCDA MSI transformations
- VideometerLab Software – Blob Toolbox

ANALYSIS- DATA EXTRACTED

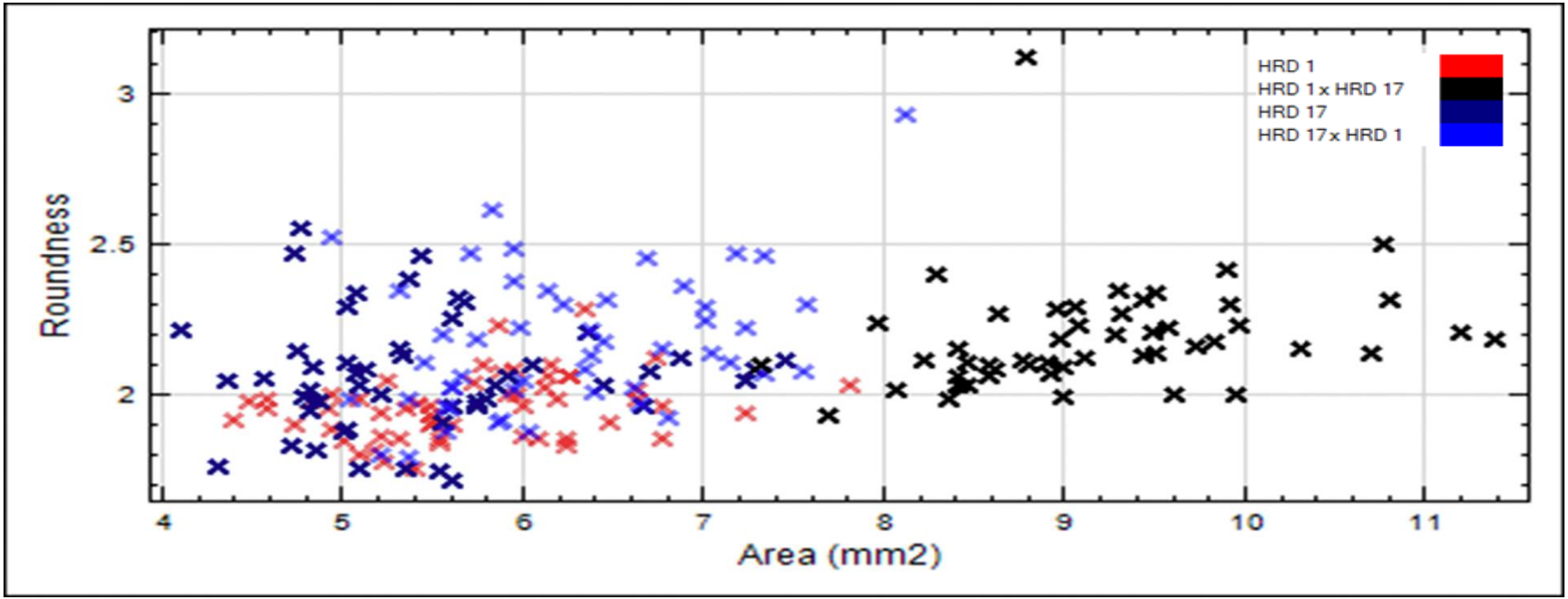
- Data extraction - VideometerLab software
- Principal component analysis
- PLS Discriminant analysis

RESULTS

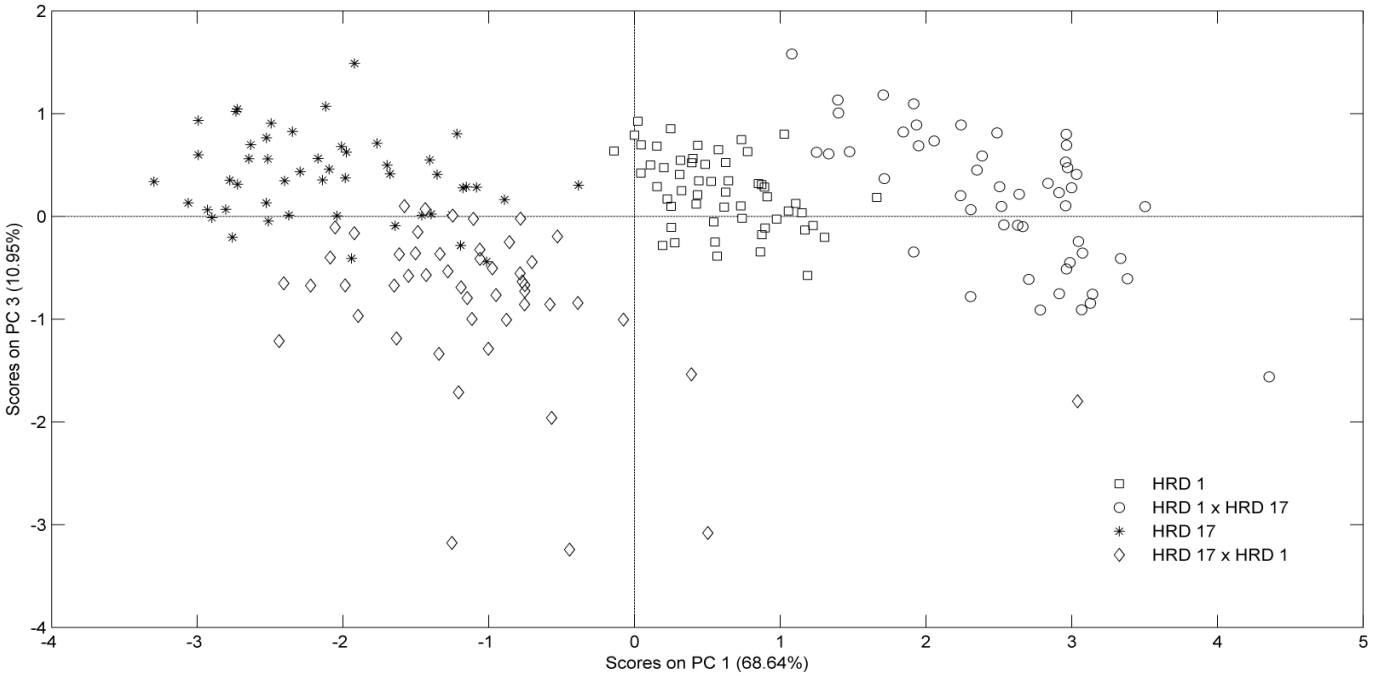
HYBRIDITY/RELATIONSHIP OF PARENTS AND HYBRIDS



SHAPE FEATURES- INCONCLUSIVE

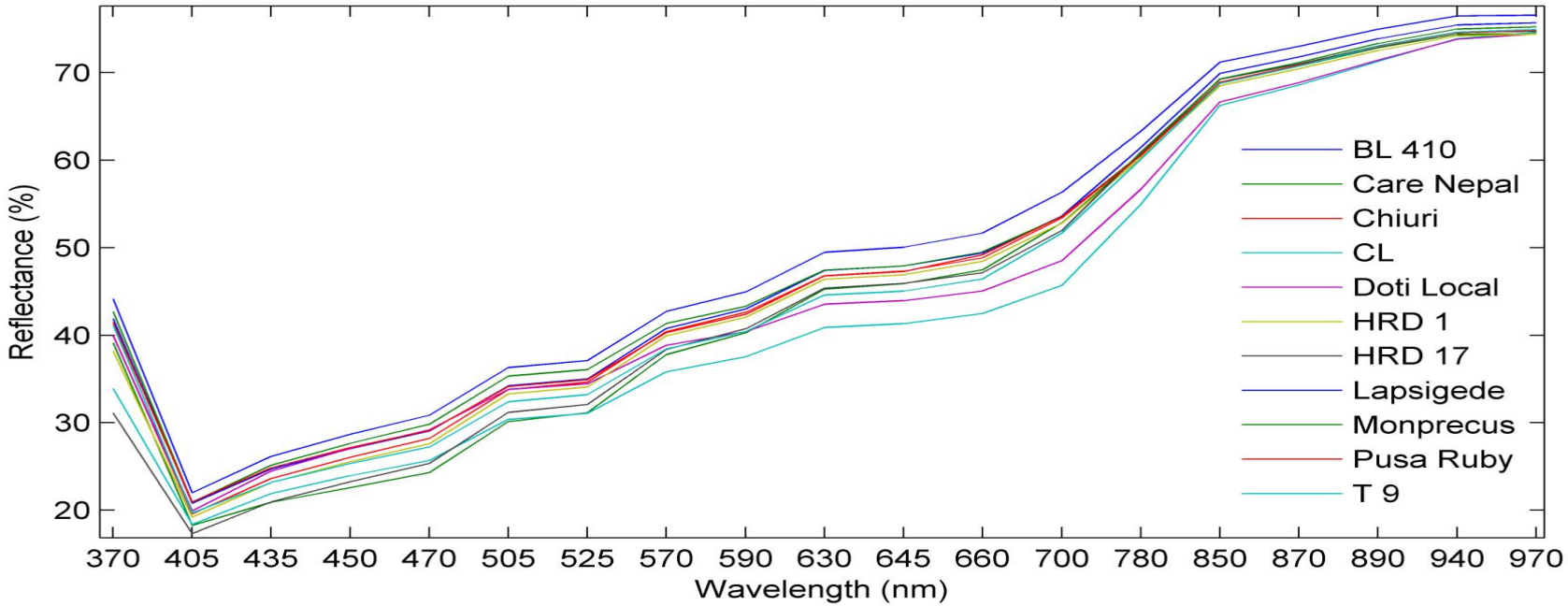


PCA – on Data Extracted

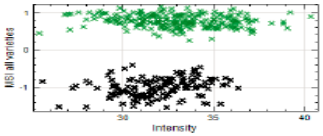


VARIETAL IDENTIFICATION / CLASSIFICATION

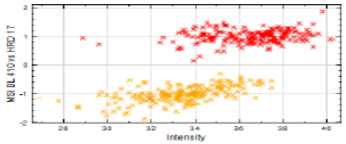
VIS-NIR MEAN SPECTRUM



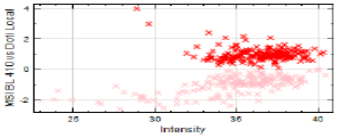
NCDA PAIRWISE DISCRIMINATION OF RANDOMLY SELECTED CULTIVARS



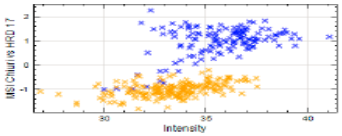
Care Nepal vs CL



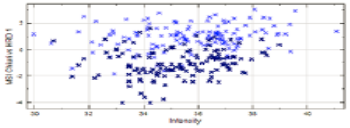
BL 410 vs HRD 17



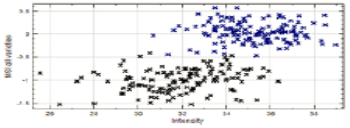
BL 410 vs Doti Local



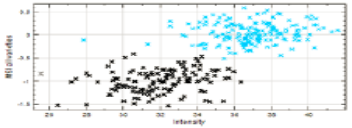
Chiuri vs HRD 17



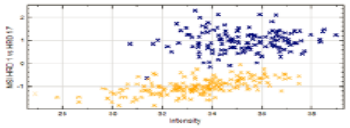
Chiuri vs HRD 1



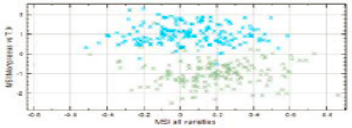
CL vs HRD 1



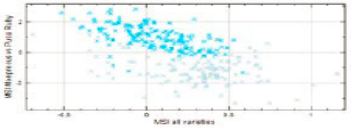
CL vs Monprecus



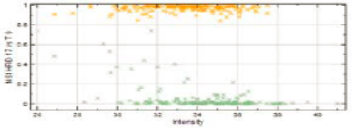
HRD 1 vs HRD 17



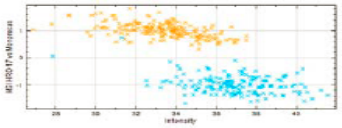
Monprecus vs T 9



Monprecus vs Pusa Ruby



HRD 17 vs T 9



HRD 17 vs Monprecus

Pairwise sensitivity of nCDA discrimination of Tomato cultivars

A. Calibration Results

	BL 410	Care Nepal	Chiuri	CL	Doti Local	HRD 1	HRD 17	Lapsigede	Monprecus	Pusa Ruby
Care Nepal	96%									
Chiuri	90%	94%								
CL	99%	100%	98%							
Doti Local	100%	100%	99%	96%						
HRD 1	94%	98%	84%	99%	100%					
HRD 17	100%	100%	97%	98%	100%	99%				
Lapsigede	94%	97%	89%	99%	100%	92%	98%			
Monprecus	98%	99%	84%	99%	96%	89%	99%	95%		
Pusa Ruby	89%	96%	81%	99%	93%	88%	99%	83%	88%	
T 9	97%	96%	94%	99%	93%	96%	100%	94%	96%	92%

B. Prediction Results

	BL 410	Care Nepal	Chiuri	CL	Doti Local	HRD 1	HRD 17	Lapsigede	Monprecus	Pusa Ruby
Care Nepal	97%									
Chiuri	78%	94%								
CL	100%	99%	97%							
Doti Local	98%	99%	98%	98%						
HRD 1	91%	98%	72%	98%	100%					
HRD 17	99%	99%	97%	96%	100%	100%				
Lapsigede	93%	99%	81%	99%	99%	92%	98%			
Monprecus	99%	99%	77%	96%	93%	86%	99%	95%		
Pusa Ruby	88%	99%	85%	95%	100%	93%	99%	86%	91%	
T 9	99%	98%	91%	95%	88%	96%	100%	93%	94%	89%

PLSDA CLASSIFICATION OF TOMATO CULTIVARS

Model A

Cultivar	Calibration	CV	Prediction
BL 410	82%	82%	90%
CL	94%	94%	95%
Care Nepal	92%	92%	97%
Chiuri	54%	53%	39%
Doti Local	91%	91%	95%
HRD 1	77%	76%	80%
HRD 17	98%	98%	98%
Lapsigede	74%	72%	70%
Monprecus	74%	73%	57%
Pusa Ruby	58%	58%	49%
T 9	91%	91%	97%
Overall Accuracy	**82%**	**81%**	**79%**

Model B

Cultivar	Calibration	CV	Prediction
BL 410	91%	90%	98%
CL	96%	96%	97%
Care Nepal	92%	92%	97%
Doti Local	92%	91%	91%
HRD 1	85%	85%	87%
HRD 17	99%	99%	100%
T 9	93%	92%	97%
Overall Accuracy (OA)	**93%**	**92%**	**96%**
Previous (OA)	**90%**	**90%**	**94%**

Model C

Cultivar	Calibration	CV	Prediction
Chiuri	83%	81%	78%
Lapsigede	92%	91%	89%
Monprecus	91%	89%	91%
Pusa Ruby	77%	75%	80%
Overall Accuracy	**86%**	**85%**	**84%**
Previous (OA)	**66%**	**65%**	**54%**

PERSPECTIVE AND SUMMARY

- Multispectral imaging – viable option for varietal identification/adulteration issues
- Initial screening in plant breeding program
- Varietal registration/certification
- Seed sorting- industrial application

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Article

Use of Multispectral Imaging in Varietal Identification of Tomato

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