

# **Status Analysis: projecting genotype performance into long-term environment discrimination space**

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# Definition: Status analysis

- Comparison of current year's environments discrimination space to the long-term discrimination space (DeLacy et al. 2000)
- This definition is extended to include genotype performance:

A projection of genotype performance from the current year's results into the long-term environment discrimination space



# Definition: Discrimination space

- Average relationships among environments (in the way in which they discriminate among the genotypes grown in them) displayed in a Cartesian space from an ordination analysis (DeLacy et al. 2000)
- Two-types of discrimination space:
  - Single-year discrimination space
  - Long-term discrimination space



# BACKGROUND

- Objective of multi-environment trials is to predict long-term genotype performance in farmers' fields
- Due to the presence of genotype by environment interactions (GE) in any single year, that GE pattern rarely reflects the long-term GE pattern
- It is expected that averaging GE over years will produce a more stable GE pattern



# METHODOLOGY

- Obtaining a single-year location discrimination space and the long-term location discrimination space → pattern analysis
- Projecting single-year genotype × location (GL) data into long-term discrimination space → status analysis



# Pattern Analysis

- Calculate GL data for each year using ASREML
  - Model:  $y = \mu + \text{trials} + \text{design} | \text{trials} + \underline{\text{G} \times \text{L}} + \varepsilon$
  - Location standardised (Fox & Rossielle, 1982)
- Calculate proximity matrix among locations
  - SED as dissimilarity matrix and correlation matrix as similarity matrix
  - Do for each year and then average over years
- Clustering strategy: Ward's method
- Ordination: Principal Component Analysis



# Symbols

$n$  = number of locations in a single-year

$m$  = number of long-term locations

$b$  = number of locations common to both a  
single-year and the long-term

$g$  = number of genotypes

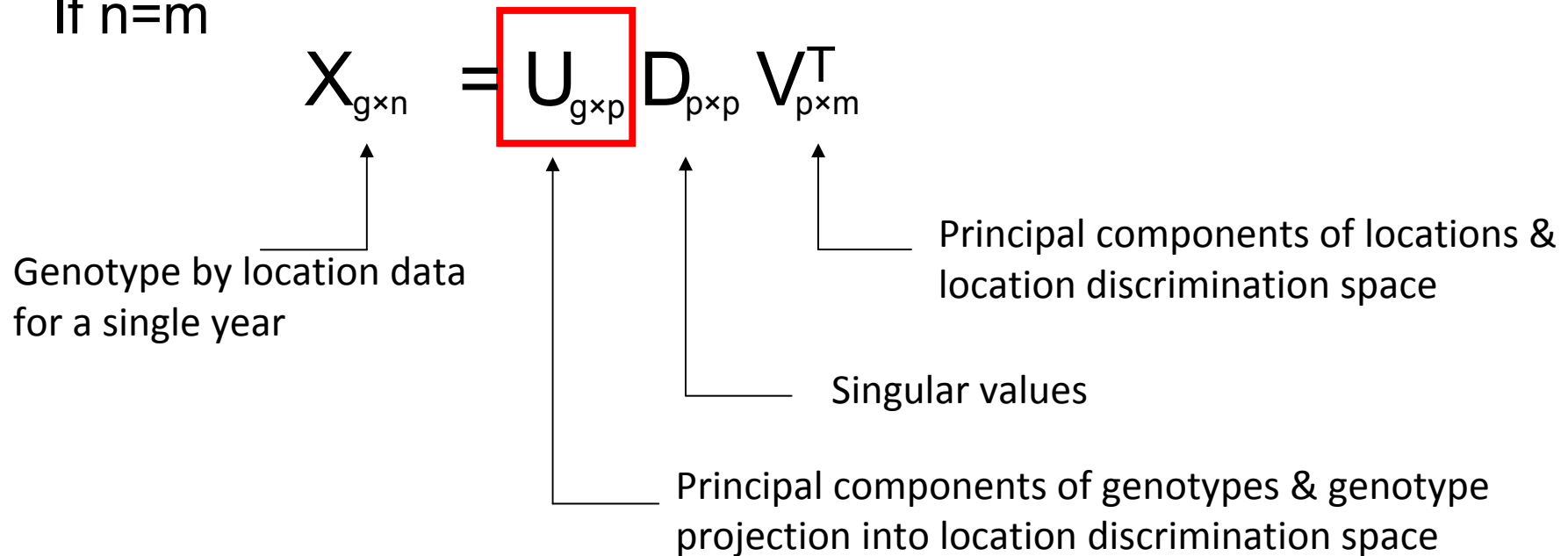
$p$  = number of principal components



# Status Analysis

Based on Singular Value Decomposition equation:

If  $n=m$



then

$$\begin{aligned} U &= X (D V^T)^{-1} \\ &= X (V^T)^{-1} D^{-1} \\ &= X V D^{-1} \end{aligned}$$



# Status Analysis contd.

If  $n \neq m$  and  $n \cap m = b$ :

$$\text{then } \mathbf{U}_{g \times p}^S = \mathbf{X}_{g \times b}^S \mathbf{V}_{b \times p}^S \mathbf{D}_{p \times p}^{-1}$$

Where:

$\mathbf{U}$  = genotype projection to long-term discrimination space

$\mathbf{D}$  = singular value of long-term discrimination space

$\mathbf{V}$  = long-term discrimination space

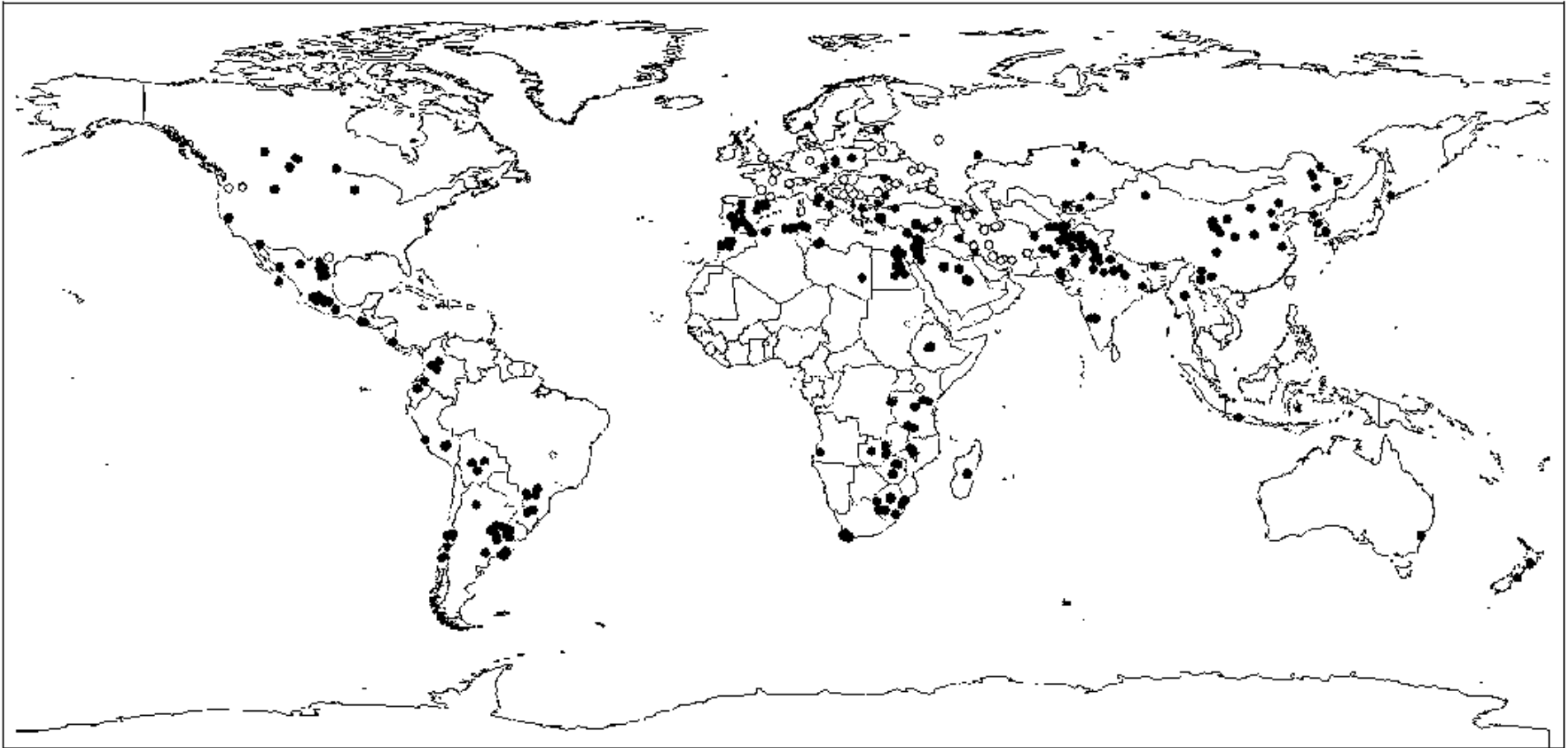


# Example

## Elite Wheat Spring Yield Trials (ESWYT)

- One of CIMMYT international nurseries
- 25 years (1979 – 2004, except 1993)
- Grain yield
- 400 locations
- 685 elite lines targeted for high-input irrigated environments





# Number of locations in the first 25 cycle of ESWYT

ESWYT Cycle (years)	ESWYT01	ESWYT02	ESWYT03	ESWYT04	ESWYT05	ESWYT06	ESWYT07	ESWYT08	ESWYT09	ESWYT10	ESWYT11	ESWYT12	ESWYT13	ESWYT14	ESWYT15	ESWYT16	ESWYT17	ESWYT18	ESWYT19	ESWYT20	ESWYT21	ESWYT22	ESWYT23	ESWYT24	ESWYT25
ESWYT01 (79/80)	17																								
ESWYT02 (80/81)	8	20																							
ESWYT03 (81/82)	9	11	22																						
ESWYT04 (82/83)	9	8	14	30																					
ESWYT05 (83/84)	7	11	15	14	38																				
ESWYT06 (84/85)	10	12	18	19	22	62																			
ESWYT07 (85/86)	7	9	13	14	21	32	72																		
ESWYT08 (86/87)	7	9	12	11	16	24	28	49																	
ESWYT09 (87/88)	8	8	11	11	15	23	28	24	58																
ESWYT10 (88/89)	5	6	9	9	12	19	22	17	24	43															
ESWYT11 (89/90)	6	8	13	13	17	23	28	18	24	21	72														
ESWYT12 (90/91)	7	8	12	14	15	19	24	17	19	21	32	64													
ESWYT13 (91/92)	5	7	12	14	17	17	21	15	20	19	22	30	51												
ESWYT14 (92/93)	3	3	6	7	8	10	12	12	13	12	16	18	22	33											
ESWYT15 (94/95)	4	6	8	10	10	14	17	16	18	13	16	21	23	20	53										
ESWYT16 (95/96)	4	5	6	7	15	15	13	15	15	12	18	19	18	17	26	69									
ESWYT17 (96/97)	2	6	9	10	11	16	17	14	17	12	19	21	20	16	24	34	68								
ESWYT18 (97/98)	6	9	12	11	15	17	17	18	18	17	21	25	26	20	33	30	33	79							
ESWYT19 (98/99)	5	10	9	9	15	15	16	17	14	14	17	21	21	16	23	28	28	42	73						
ESWYT20 (99/00)	6	4	8	8	8	12	13	13	19	11	18	23	18	14	22	24	20	34	27	69					
ESWYT21 (00/01)	6	6	10	9	12	17	20	18	21	17	18	25	22	16	25	26	27	35	37	42	91				
ESWYT22 (01/02)	5	7	9	8	10	14	16	16	18	10	14	13	14	8	16	17	19	27	26	30	42	77			
ESWYT23 (02/03)	7	8	8	10	9	15	14	15	19	14	16	18	18	15	21	22	19	25	28	32	41	43	84		
ESWYT24 (03/04)	5	5	7	6	8	15	14	16	15	12	15	16	12	8	17	21	16	24	23	30	35	31	41	70	
ESWYT25 (04/05)	4	7	6	6	9	9	9	11	9	8	12	11	8	7	11	14	14	18	19	19	21	21	29	33	63



# EXAMPLE contd.

- Long-term discrimination space:
    - Cumulative pattern analysis (DeLacy et al. 1996) over 25 years
    - Using locations that were used for a minimum of 5 years
  - Results:
    - 6 mega-environments (MEs)
    - Several released cultivars
- Substitution of location and genotype grouping



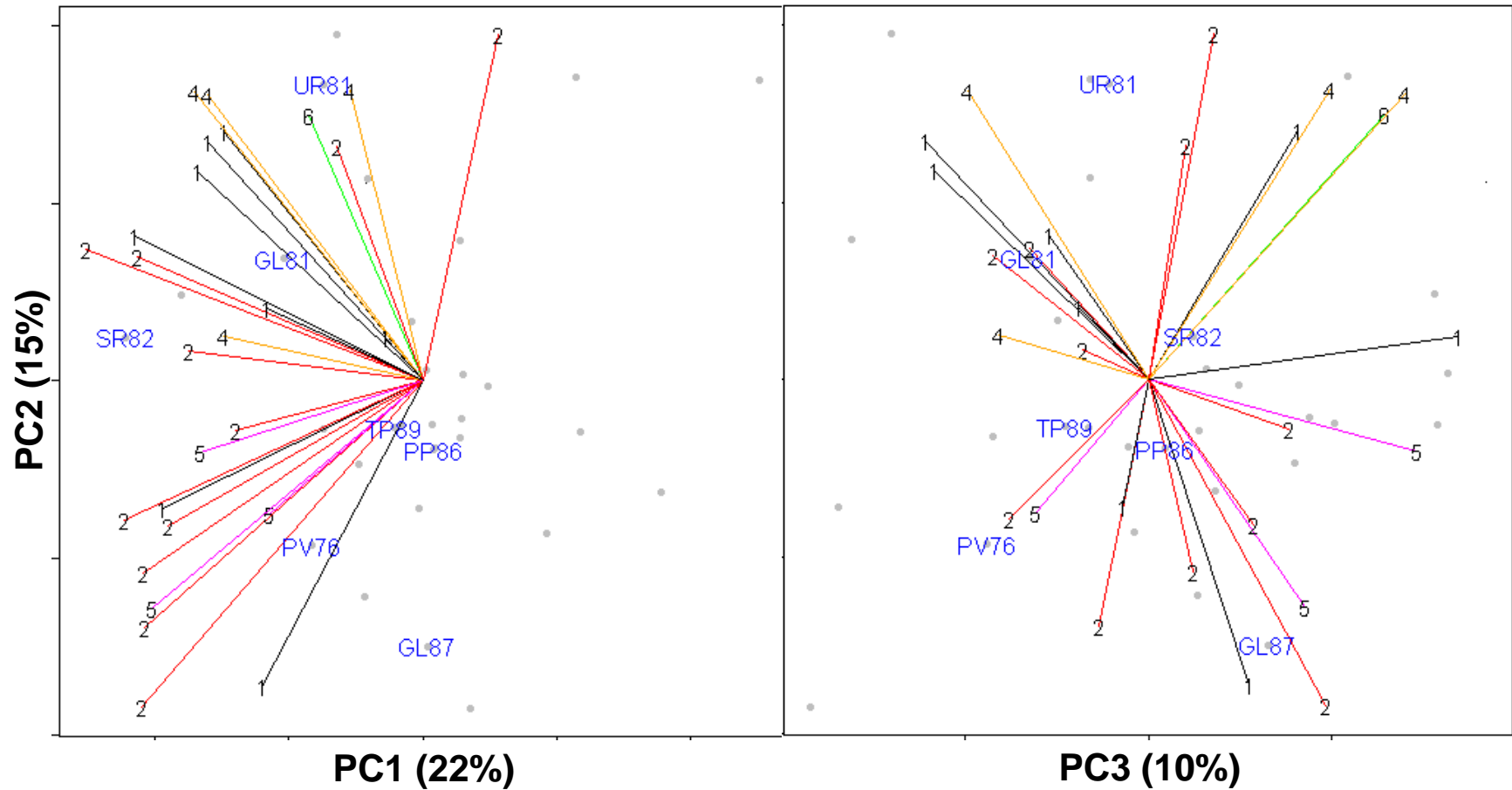
# CIMMYT mega-environment classification for spring wheat

ME	Conditions
ME1	Irrigated
ME2	High rainfall
ME3	Acid soils
ME4	Low rainfall
ME5	High temperature
ME6	High latitude

Braun et al. 1996

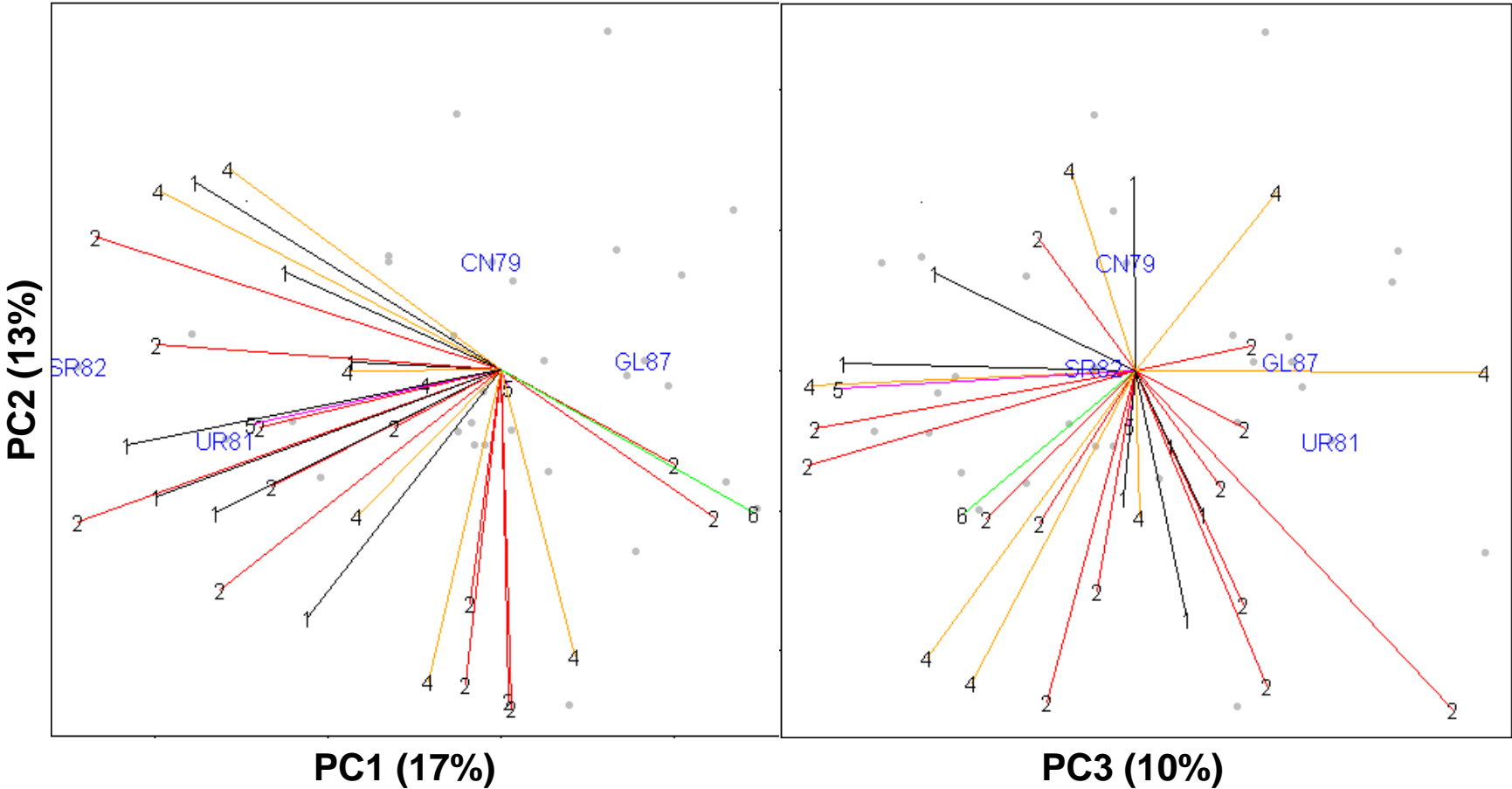


# Pattern analysis of single-year: 1983 - 1984



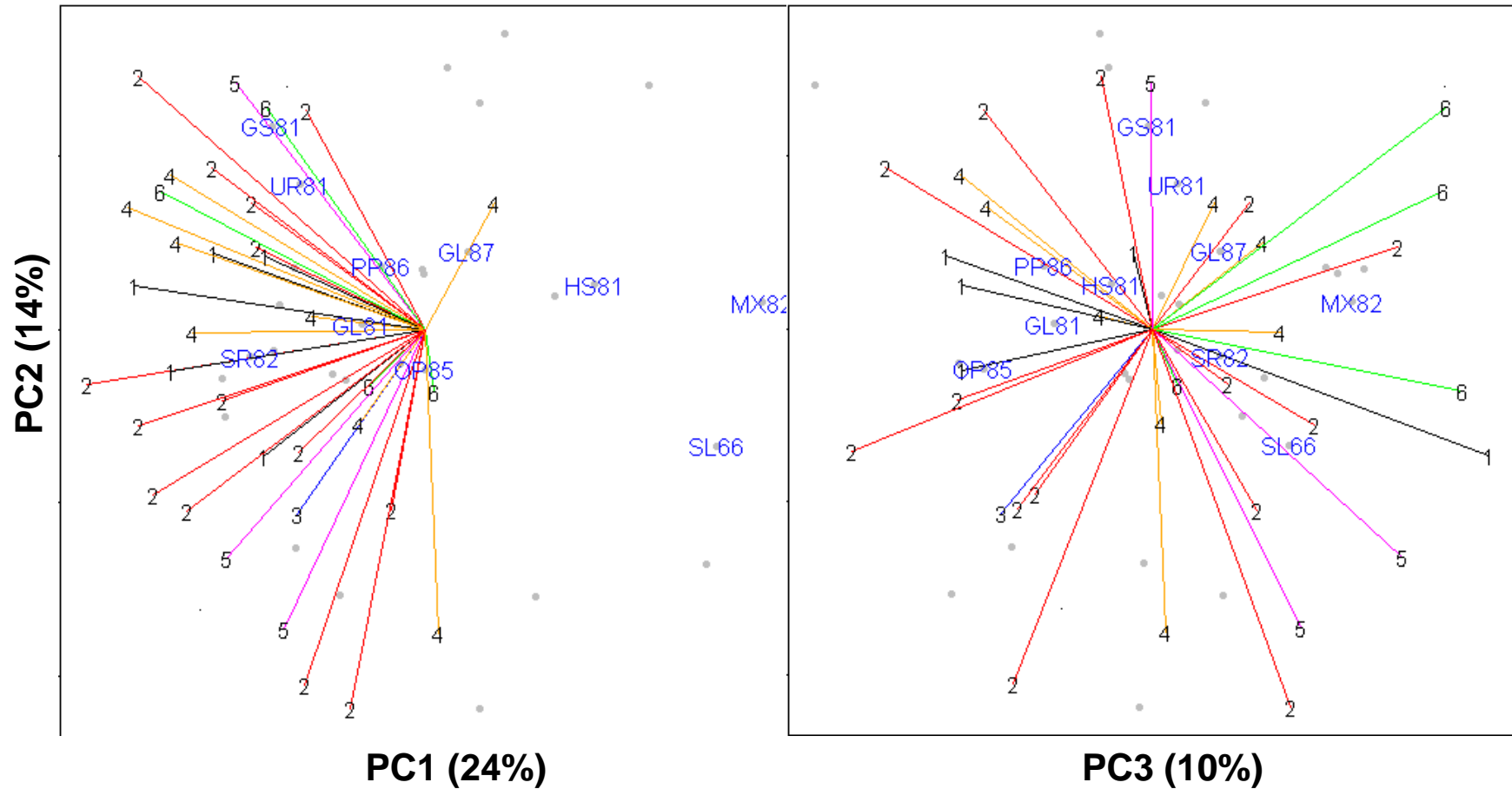
ME1 ME2 ME3 ME4 ME5 ME6

# Pattern analysis of single-year: 1984 - 1985



ME1 ME2 ME3 ME4 ME5 ME6

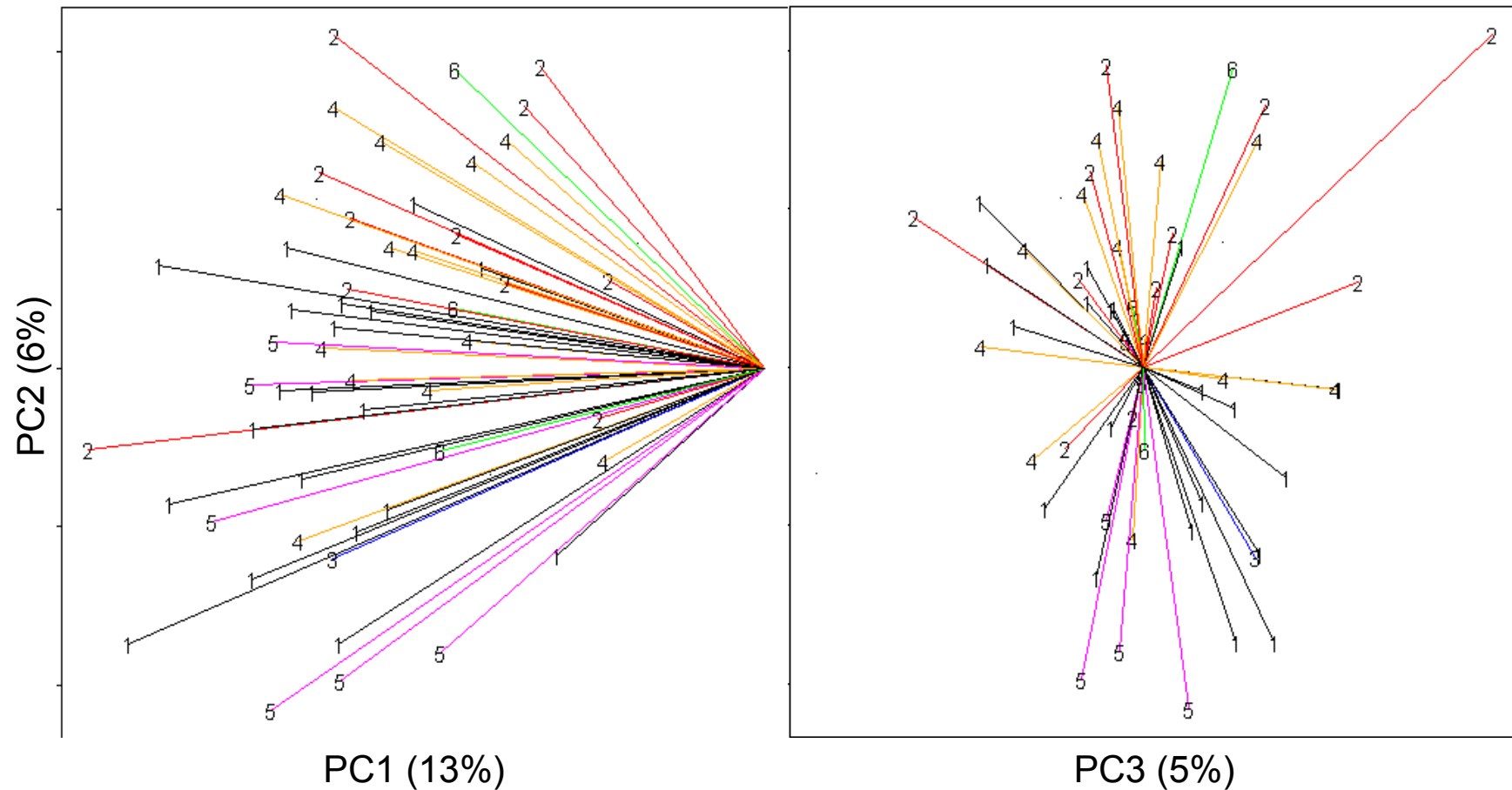
# Pattern analysis of single-year: 1985 - 1986



ME1 ME2 ME3 ME4 ME5 ME6

# Long-term discrimination space

## 57 locations



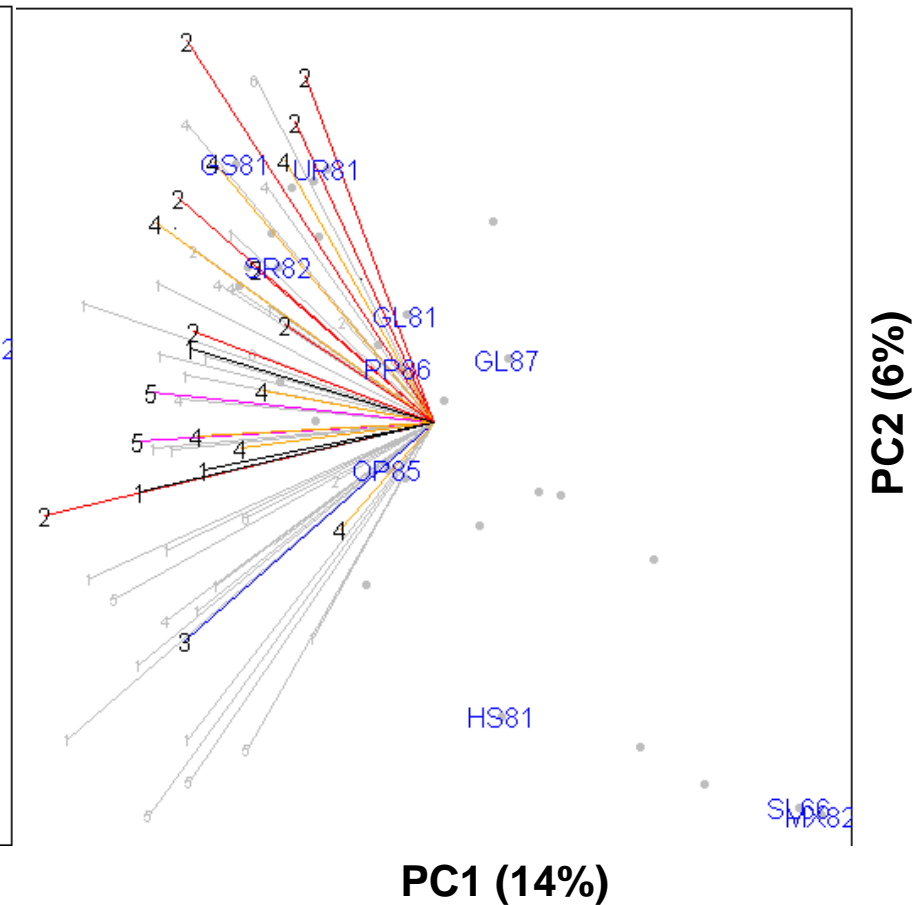
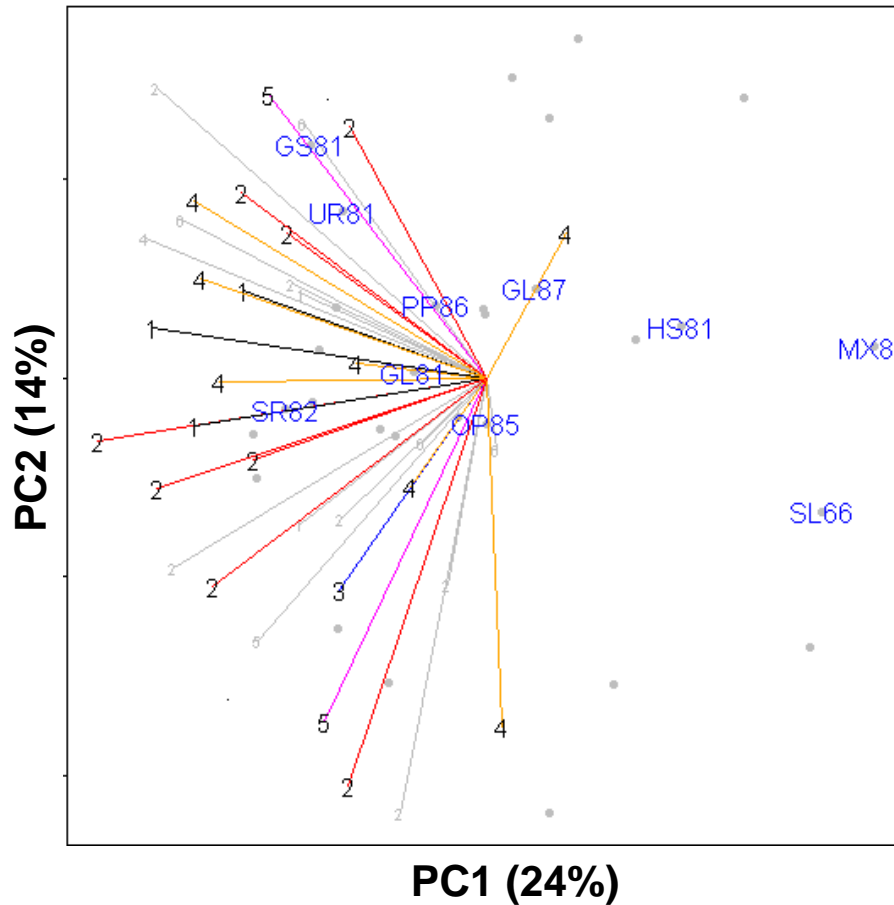
ME1 ME2 ME3 ME4 ME5 ME6

# Status Analysis: 1985 – 1986

## PC1 and PC2

Single-year

Long-term



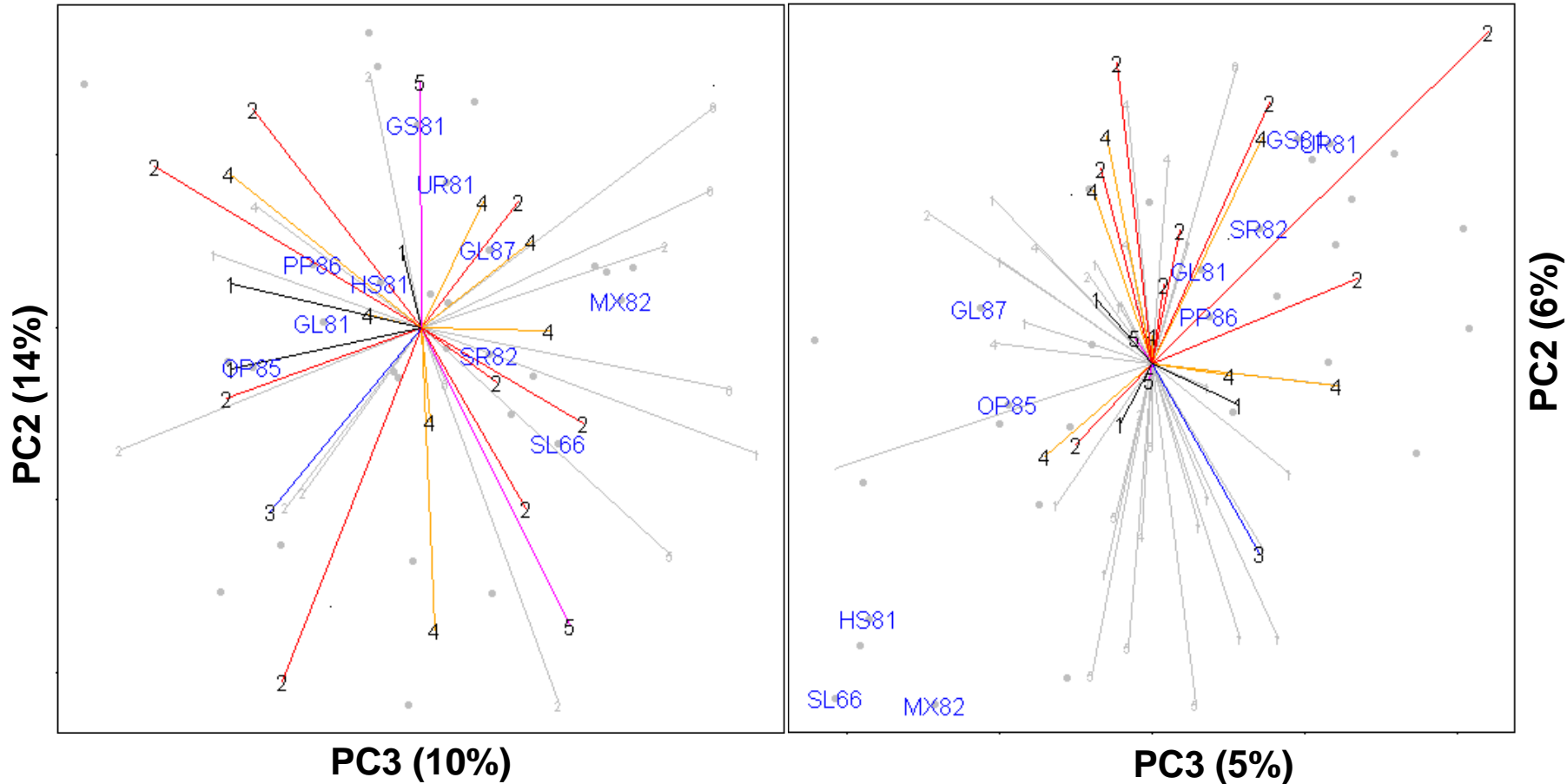
ME1 ME2 ME3 ME4 ME5 ME6

# Status Analysis: 1985 – 1986

## PC2 and PC3

Single-year

Long-term



ME1 ME2 ME3 ME4 ME5 ME6

Australasian Applied Statistics Conference, 12 - 15 July 2011, Palm Cove

# Summary

- Discrimination space:
  - PC1 – reflects average genotype performance
  - PC2 & PC3 – reflects G×E interactions
- Status analysis:
  - Project genotypes performance in long-term space including in locations they were not tested
  - Evaluate similarity between current year pattern & long-term GE pattern
- Long-term discrimination space:
  - Updated with additional data
  - Re-done when there were major changes in germplasm or test locations



# References

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- FOX, P. N. & ROSIELLE, A. A. 1982. Reducing the influence of environmental main effects on pattern analysis of plant breeding environments. *Euphytica*, 31, 645-656.
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