



Impact of Environmental Variation on Color Trait Expression and Its Challenge to DUS Testing

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Content



● **What- Color Variation in Different Environments**
.....

● **How— Improving Color Testing Practices**
.....

Case 1



Figure 1: Anthocyanin coloration intensity of lemma (early observation).



Figure 2: Anthocyanin coloration intensity of lemma (late observation).

| | B1 | B2 | B3 |
|-------------|------------|---------|------------|
| condition | greenhouse | shelter | open field |
| sunlight | weak | medium | strong |
| temperature | high | medium | low |

All of data from Liu, *et al.*, 2014

Case 2



Figure 3. Petal coloration of variety of ‘Doppio Pandora-purple’ of *Ranunculus asiaticus* L. (Liu, *et al.*, 2022)

Note: A: flower at the stage of florescence; B: upper sides of outer petals; C: lower sides of outer petals; the left one (two) was (were) in the condition of control (8:00-20:00: 18°C; 20:00-8:00: 8°C), while the right one (two) was (were) under the stress of 5°C decrease (8:00-20:00: 13°C; 20:00-8:00: 3°C) after budding.

Case 3

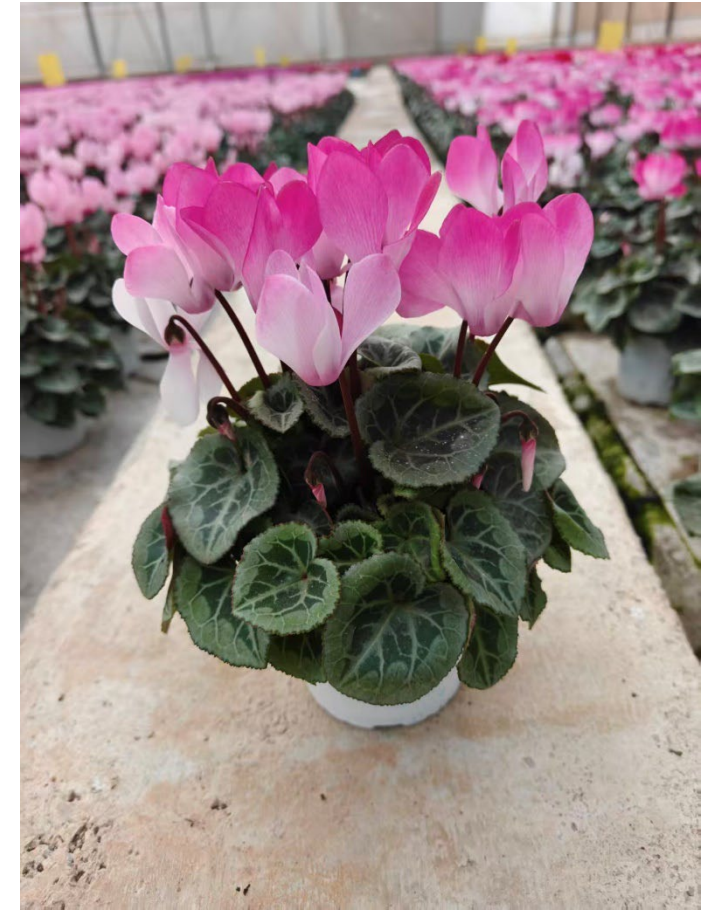


Figure 4. Cyclamen variety 'Mirage' under different environmental conditions
(provided by Kunming Binfen Horticulture Co., Ltd.)

Content



● **What- Color Variation in Different Environments**
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● **How— Improving Color Testing Practices**
.....

Pigment metabolic pathways vary among different crops.

Transcriptional regulatory mechanisms also differ under different environmental conditions



How to perform DUS testing on color-related traits?

Point 1



- **Side-by-side testing mode**
- **Special attention must be paid to light conditions, e.g. shading, angle of light exposure.**

Point 2

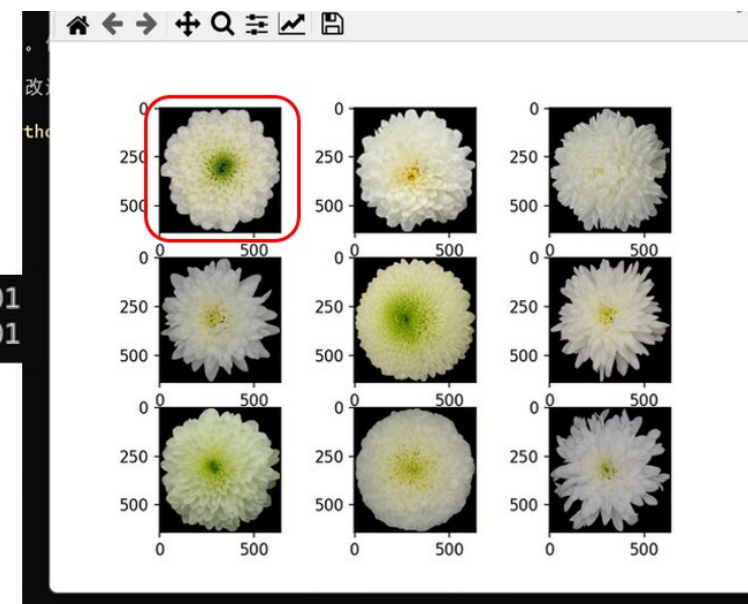


```
pred: 0400010101 real: 0400010101  
pred: 0400010101 real: 0400010101
```

1 2 3 4 5

↑
系统预测结果
System prediction result

↑
人员目测结果
Artificial judgment result



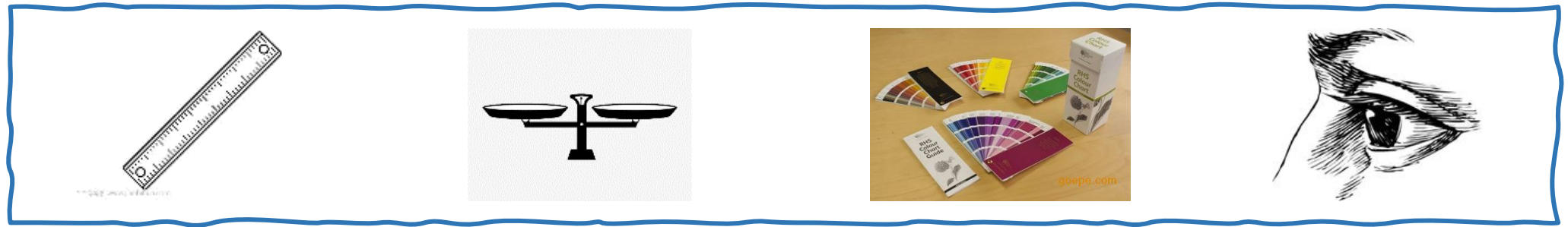
➤ When screening similar varieties, attention should be paid to color-related traits.

Point 3

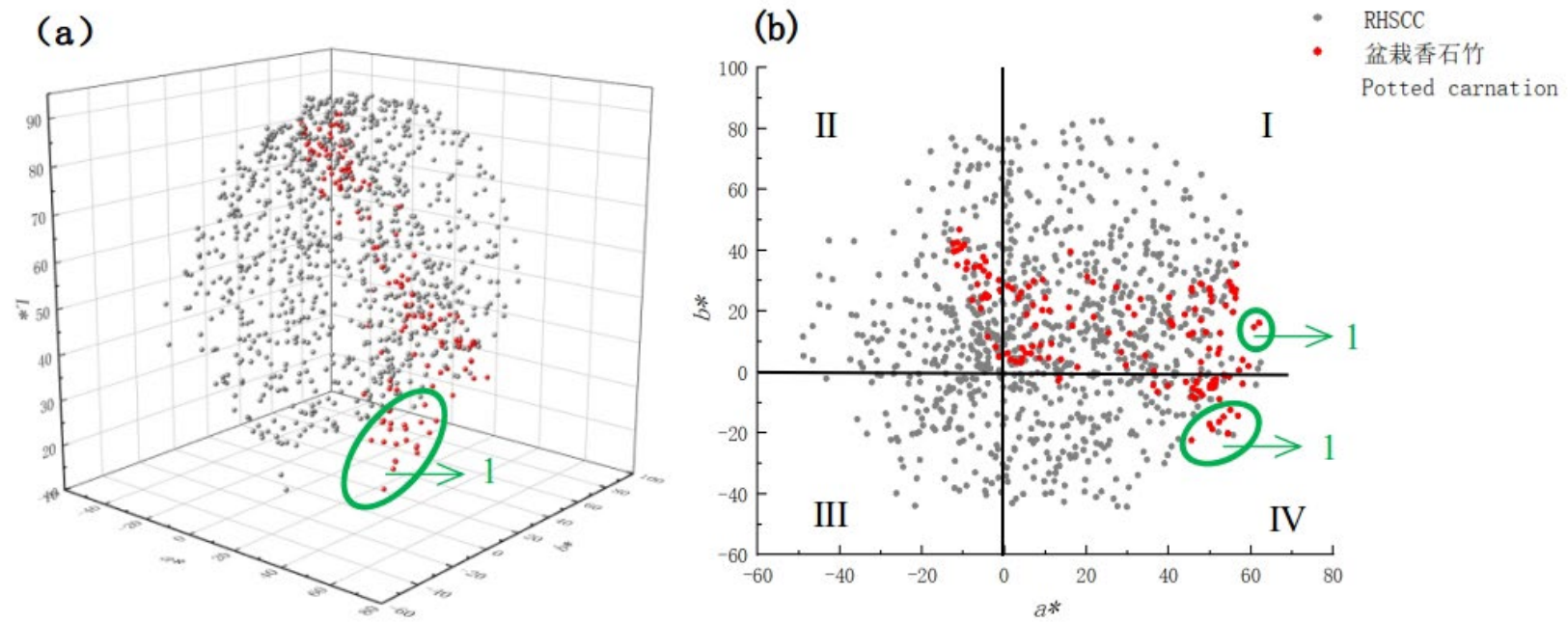


- In PVP disputes, the use of color-related traits should be approached with caution.

Point 4



- **Objective and accurate testing methods are very important.**

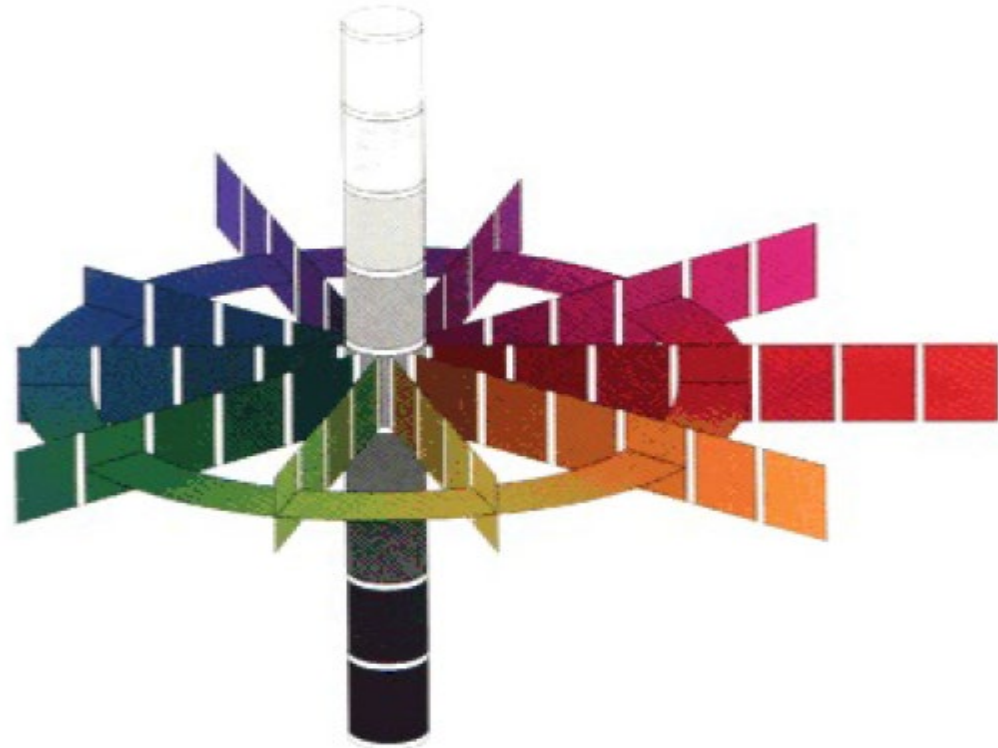


(a) L^* 、 a^* 和 b^* 三维分布图; (b) a^*b^* 二维分布图。1 表示 RHSCC 未覆盖花色。

Figure 18. Color space distribution of RHSCC colors and flower colors of 150 potted carnation varieties (Teng, *et al.*, 2022)



Figure 19. Examples showing the difficulty in flower color matching using RHSCC (Teng, *et al.* 2022)



Precise quantitative and qualitative analysis on color traits


- On one hand, improve the scientific rigor and accuracy of DUS testing;
- On the other hand, facilitate the localization and mining of molecular markers associated with color traits by integrating environmental data.

植物颜色性状分析系统

文件(F) 设备特性化(C) 植物颜色分析(A) 工具(T) 帮助(H)

总览 颜色分析 设备特性化 系统参数

原始图-E:\腾彩铃\实物\DMG_5176.JPG



颜色聚类:

| | | | | | | | | | |
|-----------------|--------|--------|--------|-------|------|------|------|------|------|
| LAB color space | | | | | | | | | |
| 34.57% | 28.16% | 20.17% | 12.09% | 5.01% | | | | | |
| 63.3 | 40.4 | 40.5 | 87.2 | 8.8 | 78.7 | 74.8 | 28.4 | 60.4 | 90.5 |
| 5.8 | 53.5 | 91.8 | 8.7 | 9.2 | | | | | |

| | | | | |
|-----------------|-----------|-----------|-----------|-----------|
| RHS color chart | | | | |
| 170A E:2.2 | 15A E:0.8 | 25A E:2.7 | 16B E:2.0 | 27A E:3.1 |

孟塞尔色调分割:

| | | | | | | | | | |
|---------------------|-------------|-------------|---------|---------|---------|-------|-------|---------|-----|
| Munsell color space | | | | | | | | | |
| 43.63% | 38.32% | 15.82% | 1.10% | 0.60% | 0.13% | 0.13% | 0.01% | | |
| 4.9YR | 6.9/10.4 | 5Y | 8.6/9.8 | 9.6R | 6.2/9.9 | WHT | 2.2Y | 8.8/8.6 | 5RP |
| 9.2/1.8 | 6.9/3.1/1.4 | 6.9/3.1/1.5 | 5.3PB | 9.2/1.1 | | | | | |

| | | | | | | | | | |
|-----------------|-------------|-----|---------|----|---------|----|-------|-----|---------|
| Munsell STD hue | | | | | | | | | |
| 5YR | 6.9/10.4 | 5Y | 8.6/9.8 | 5R | 6.2/9.9 | 5Y | 8.8/0 | 5RP | 9.2/1.8 |
| 6.9/3.1/1.4 | 6.9/3.1/1.5 | 5PB | 9.2/1.1 | | | | | | |

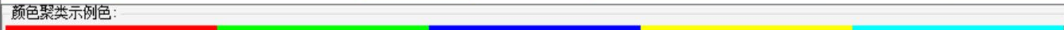
RHS色卡主色分割:

RHS main colors: orange:49.55% brown:24.29% red:11.66% yellow:11.51% pink:2.87% violet:0.08% grey:0.02% white:0.01% blue:0.00%

83.2 16.1 63.264.3 38.4 41.663.2 42.5 38.788.5 6.8 81.4 90.9 12.6 3.1 94.0 7.7 -7.7 94.0 1.2 -1.3 94.8 2.5 -1.7 95.4 1.2 -4.1

| | | | | |
|-----------------|-------------|------------|-----------|-----------|
| RHS color chart | | | | |
| 23B E:2.2 | N172C E:2.7 | 170A E:1.7 | 17C E:0.8 | 39D E:1.8 |
| 76C E:1.7 | 202D E:3.7 | 37D E:2.7 | | |

颜色聚类示例色:



目标颜色

RGB: 243, 242, 247
XYZ: 117.0, 122.5, 151.2
Lab: 108.1, 1.1, -9.2
孟塞尔(H V/C): N9.9
RHS: N155B -> Lab 101.7, 1.1, -3.3 DeltaE: 5.9

色度信息:
主色: RGB: 233 125 59
色度坐标(x, y): 0.492, 0.3690, 13

报告

品名: 花毛茛-2

目标颜色聚类RHS色卡定性分析结果:
1. 共含 5 种色系;
2. 复色, 其中, 主色 orange brown 占比34.57%, 次色 dark yellow 占比28.16%;
3. 其他.

目标孟塞尔色调分割定性分析结果: |
1. 共含 8 种色调;
2. 复色, 其中, 色调YR 占比43.63%, 色调 Y 占比 38.32%;
3. 其他.

目标RHS主色分割定性分析结果:
1. 共含 9 种主色;
2. 复色, 其中, 主色orange 占比49.55%, 主色 brown 占比24.29%;

生成报告

- quantitative analysis
- RHSCC matching / error showing
- qualitative analysis
- mono- / multi-color determining

background removing color clustering



Thank you