

Identification of the phenotypic variation and establishing a digitized botanical repository for the genus *Cannabis*

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Introduction

- Taxonomy of hemp (*Cannabis sativa* L. - Fig.1) is controversial¹
- Deficiency in botanical data for decision making^{1,2}:
 - Breeding, regulation, industrial applications, etc.
- Morphological studies necessary but difficulties in identification:
 - Genetic reticulation within single 'species'
- Nomenclatural issues²: need of well-curated specimens
- Focus: seed-type strains

Questions

- 1) How does morphological diversity of hemp strains affect seed production?
- 2) How to address the nomenclatural issues of hemp strains?

Hypothesis—Seed-type hemp strains have no difference among morphology

Methods

Live hemp strain collection

Herbarium specimens

Microscopy

Digitization

ImageJ

Image processing

Morphometry

Database

Statistical analyses

References

- [1] Koren et al, 2020. *Genetica* 52: 1-13; [2] Reimann-Philipp et al, 2020. *Cannabis and Cannabinoid Research*. 5(3); [3] Naraine et al, 2020. *Genetic Resources & Crop Evolution*. 67: 703-714; [4] Schaffner, 1921. *IJPS*. 71(3)



Fig. 1. Compactness of infructescences of *Cannabis sativa* (X) alternate & dispersed-Jin Ma, (Y) clustered-Sweet sensi (photo: P. Amarasinghe)

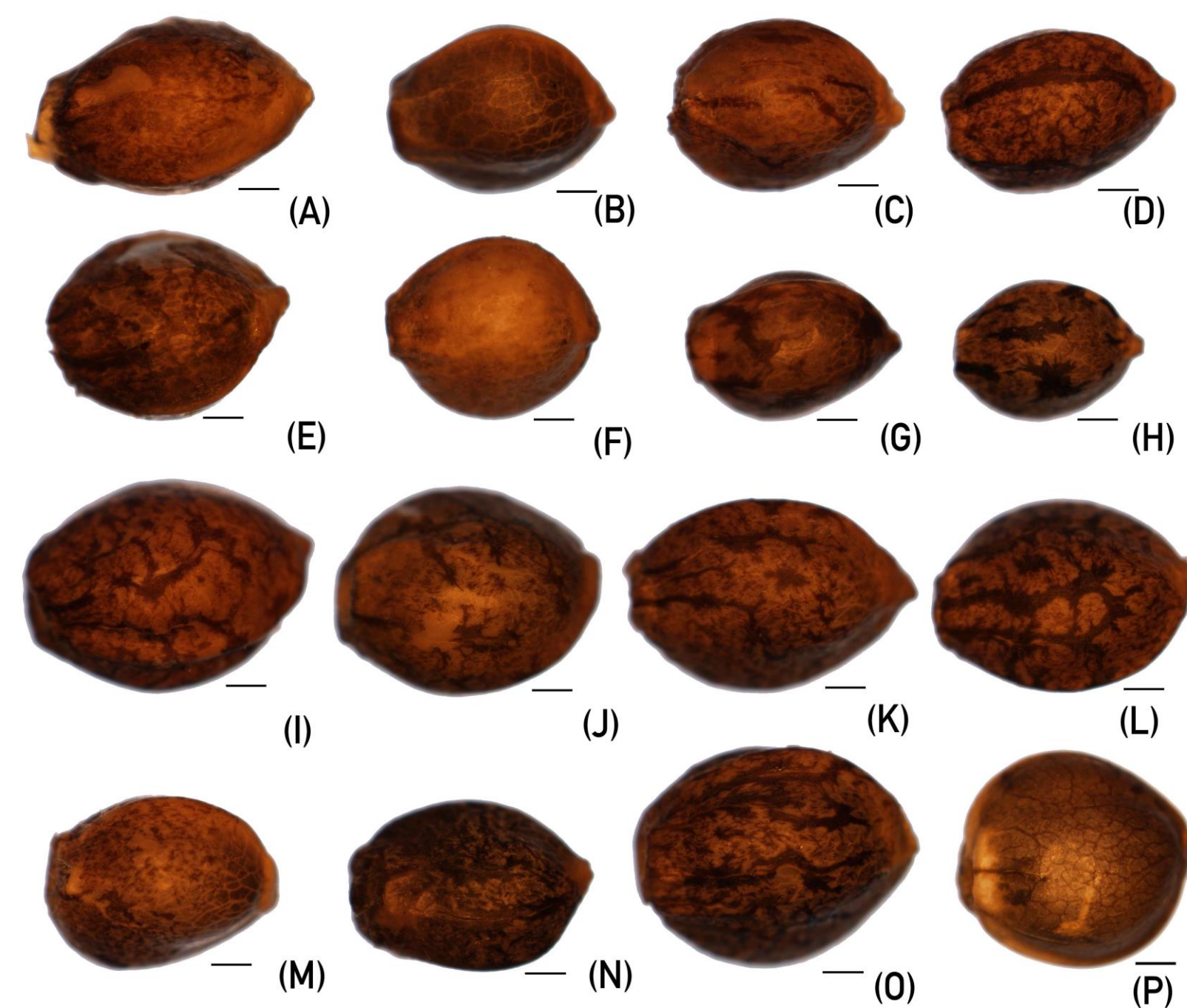


Fig. 2. Morphological variations of seeds of *Cannabis sativa* strains: (A) Abacus (B) American Victory2 (C) Blue genius (D) Blue kross (E) Cherry blossom (F) Cherry wine (G) Ditchweed (H) Ditchweed-Colorado (I) Jin Ma (J) KLR2014 (K) Lyndora (L) Money maker (M) Portland (N) Sweet sensi (O) Unknown strain (P) USO31. x63 scale bar=2mm (photos: P. Amarasinghe)

Fig. 3. Morphological variations of achenes of *Cannabis sativa* strains: (A) Abacus (B) American Victory2 (C) Blue genius (D) Blue kross (E) Cherry blossom (F) Cherry wine (G) Ditchweed (H) Ditchweed-Colorado (I) Jin Ma (J) KLR2014 (K) Lyndora (L) Money maker (M) Portland (N) Sweet sensi (O) Unknown strain (P) USO31. x63 scale bar=2mm (photos: A. Ware & P. Amarasinghe)



Results

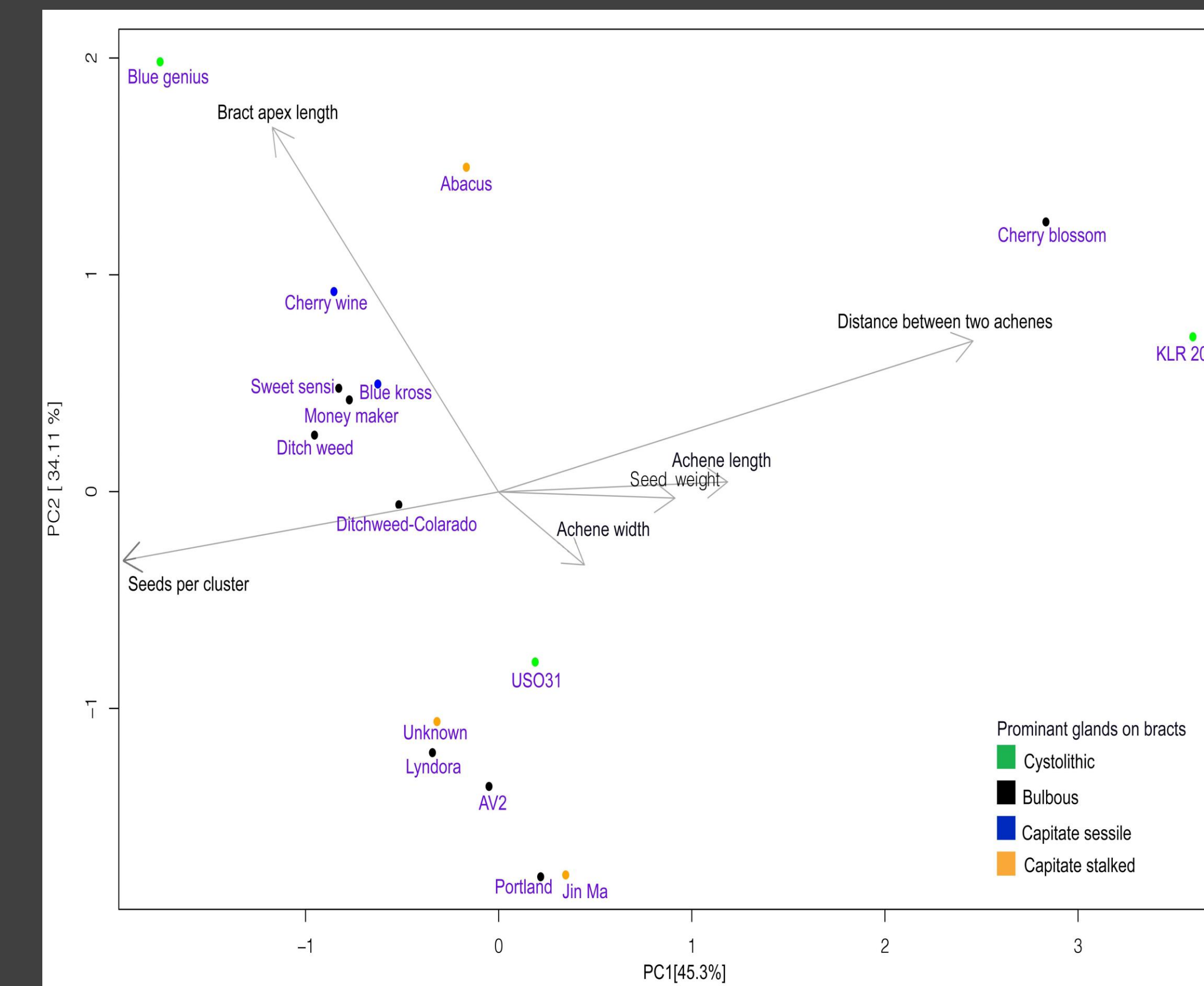


Fig. 4. The strain by trait biplot which illustrates the relationship between PC1 and PC2 for 16 strains and six traits of seed-type hemp

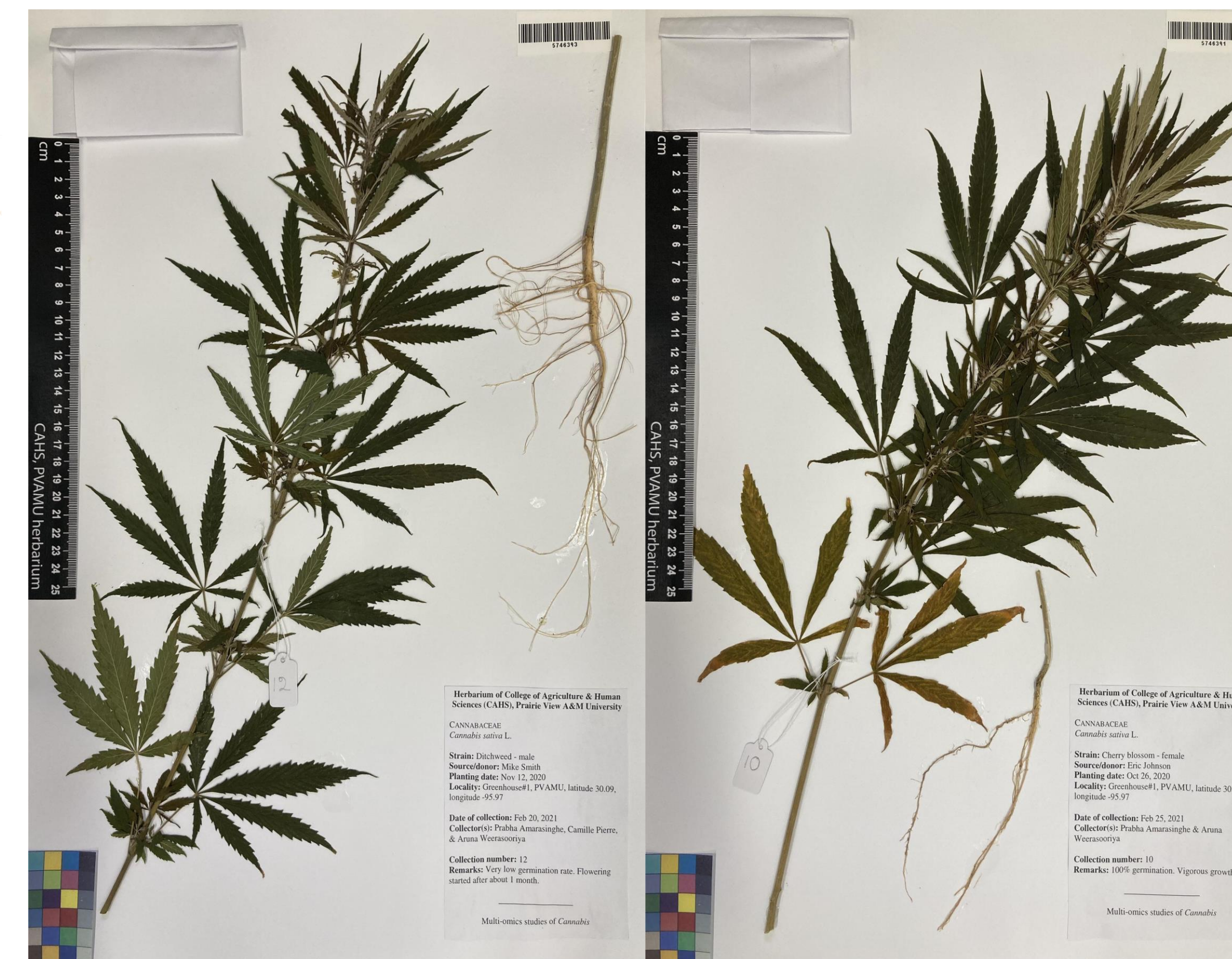


Fig. 5. Herbarium specimens of *Cannabis sativa* for digital herbarium

- A significant difference among strains: 6 traits ($p < 0.05$) (figs. 2 & 3)
- Important qualitative character: trichomes
- Jin Ma strain remained consistent with largest seed weight
- Collection of 70 specimens for the digital repository (e.g., Fig 5)
- PC1 of the PCA biplot interpret the major differentiations (45.3%) of hemp strains (Fig. 4)

Discussion

- Significant morphological diversity among seed-type hemp strains and some are functional characters³
- Some characters did not show significant differences: environmentally plastic⁴
- Morphological data will contribute to the preliminary identification of seed-type hemp strains for genetic studies
- Ongoing digital repository: an open resource for hemp researchers

Conclusion

- Seed-type hemp strains showed significant difference among six morphological traits
- A significant total variation (79.4%) explained by PCA, but need more traits and accessions to clearly differentiate clusters
- Digital collection will expand nomenclatural knowledge of *Cannabis*

Future Studies

- More characters (functional traits), additional strains
- Continue to work on the digital repository
- Ongoing chemical analysis of seed-type strains
- Genomics - targeting genetic variations

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