Assisted Few-Shot Learning for Vision-Language Models in Agricultural Stress Phenotype Identification

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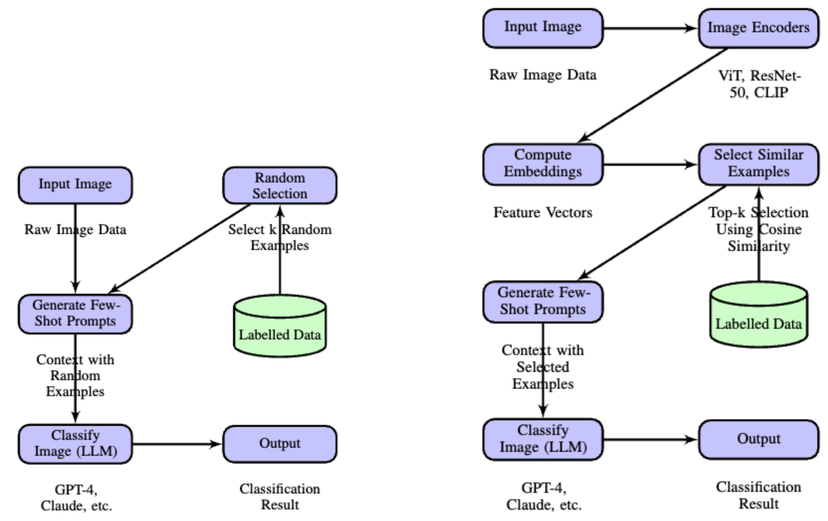
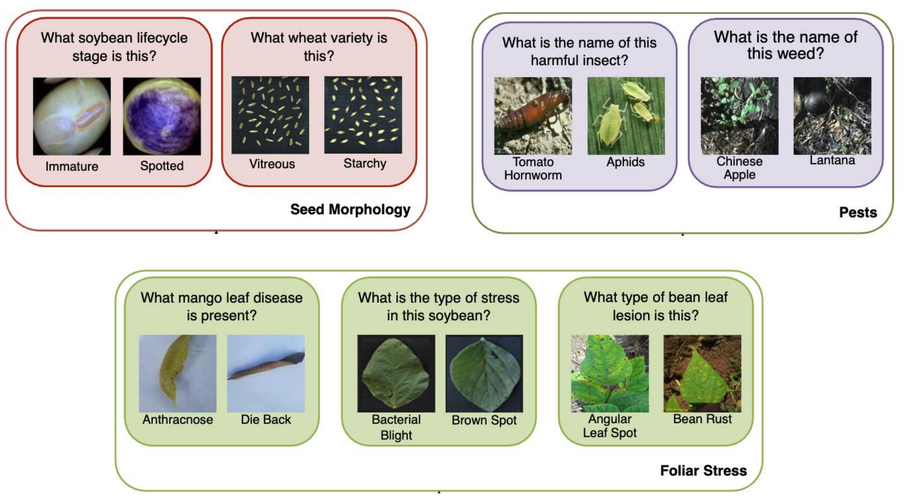
Introduction

- **Addresses critical challenge of limited labeled datasets in agricultural stress phenotyping.**
  - Expert annotation requires significant time and resources
  - Agricultural stress identification needs diverse, high-quality examples
  - Current vision-language models show promise with few examples
- **Presents Assisted Few-Shot Learning for agricultural image classification.**
  - Intelligently selects most relevant examples using image encoders
  - Optimizes performance with as few as 1-8 labeled examples
  - Enables practical deployment with minimal data requirements



Analysis



AgEval Benchmark Tasks for Agricultural Stress Identification

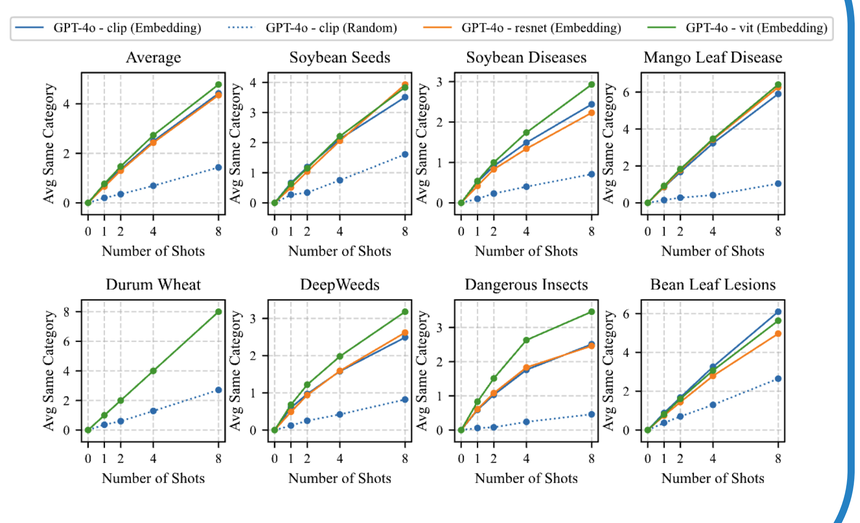
(a) Sample image

Category	Subcategory	Task
Identification (I)	Foliar Stress	Bean Leaf Lesions

Question: What type of bean leaf lesion is this?
Ground Truth: Bean Rust

Method	Examples			
VIT-based	 Bean Rust	 Bean Rust	 Bean Rust	 Angular Leaf Spot
Traditional	 Angular Leaf Spot	 Angular Leaf Spot	 Angular Leaf Spot	 Healthy

Example Selection: Traditional vs Assisted Few-Shot



Average Same-Category Retrieval Across Shot Counts

Results

- **ViT encoder achieves highest average F1 score (80.45%) in 8-shot scenario.**
- **Consistent performance gains across 6 out of 7 agricultural tasks.**
  - Intelligently selects most relevant examples using image encoders
  - Optimizes performance with as few as 1-8 labeled examples
  - Enables practical deployment with minimal data requirements
- **Consistent performance gains across 6 out of 7 agricultural tasks.**
  - DeepWeeds: +26.47% improvement
  - Mango Leaf Disease: +22.31% improvement
  - Soybean tasks: +20.23% average improvement

Table: Assisted Few-Shot Performance Comparison with Baseline (8-shot)

Task	Baseline	clip	resnet	vit
Bean Leaf Lesions	88.34	91.96 (+3.62)	91.98 (+3.64)	90.06 (+1.72)
Dangerous Insects	84.21	79.33 (-4.88)	82.23 (-1.98)	81.41 (-2.80)
DeepWeeds	56.99	67.54 (+10.55)	72.26 (+15.27)	83.46 (+26.47)
Durum Wheat	97.98	100.00 (+2.02)	100.00 (+2.02)	100.00 (+2.02)
Mango Leaf Disease	76.65	98.96 (+22.31)	93.71 (+17.06)	94.31 (+17.66)
Soybean Diseases	32.43	44.88 (+12.45)	48.66 (+16.23)	52.66 (+20.23)
Soybean Seeds	44.16	57.42 (+13.26)	65.29 (+21.13)	61.26 (+17.10)
Average	68.68	77.16 (+8.48)	79.16 (+10.48)	80.45 (+11.77)

Conclusion

- Successfully demonstrated effectiveness of Assisted Few-Shot Learning through significant F1 score improvements (68.68% to 80.45%)
- Validated performance across multiple encoder architectures with ViT showing strongest results
- Established viable approach for agricultural stress phenotyping with limited labeled data
- Demonstrated broad applicability with improvements in 6 out of 7 agricultural tasks

Future work

- Extend methodology to smaller, resource-efficient vision-language models
- Explore additional similarity metrics beyond cosine similarity for example selection
- Apply assisted few-shot framework to broader agricultural monitoring applications

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