Using spatial metrics to assess crop stressed by pests: Case of wheat fields infested by *Diuraphis noxia*

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Outline

- Introduction
- Objectives
- Methodology
- Results
- Conclusion

Introduction

- scouting for aphids is time consuming and expensive
- use remote sensing technology to detect stressed areas of wheat fields
- difficult to differentiate stress induced by *D. noxia* from other stress factors
- use spatial pattern metrics from GIS

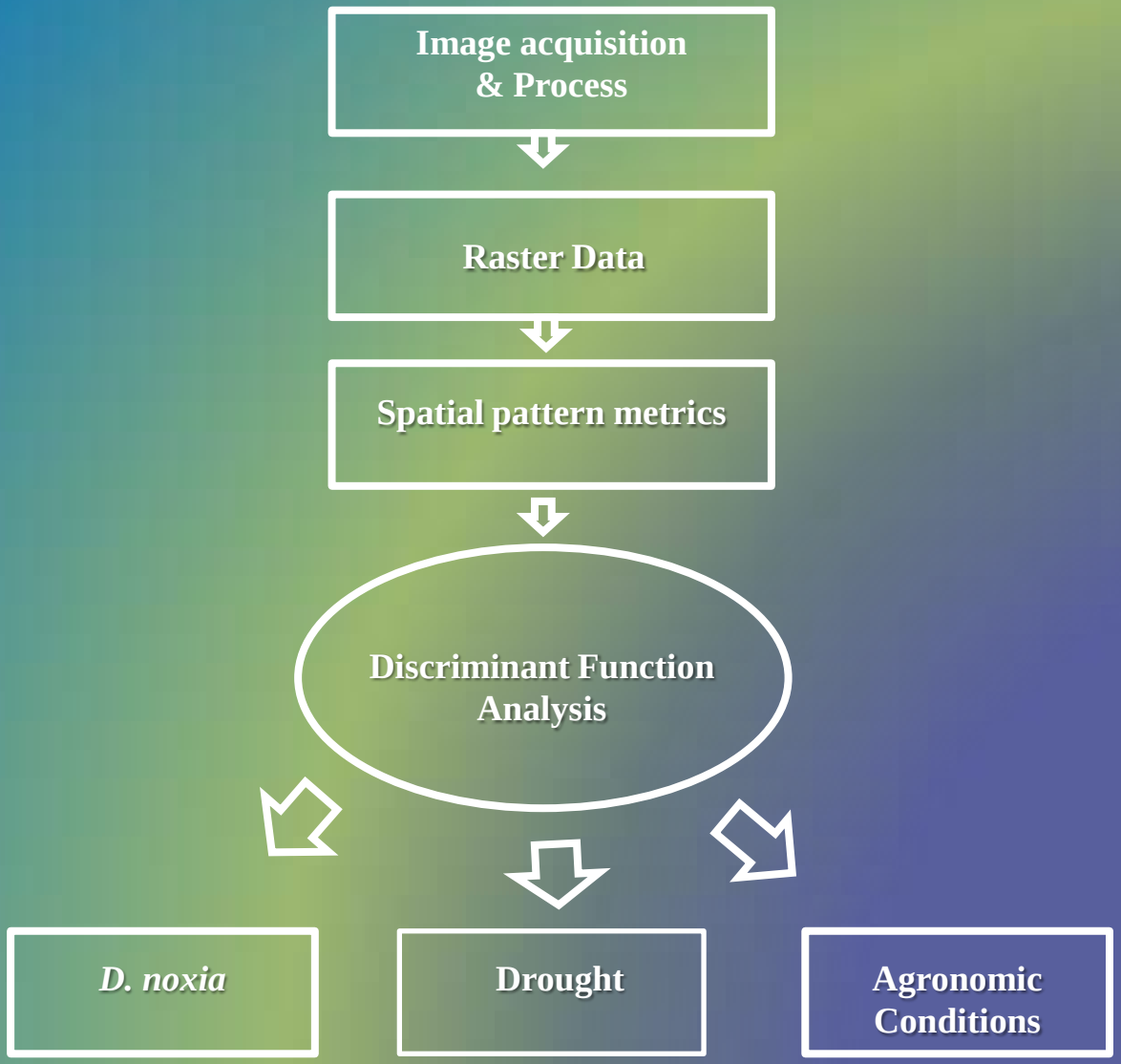
Objective

Investigate a transferability approach to spatially differentiate stress induced by *D. noxia* in wheat fields, that can be applied to cotton fields infested by Lygus bugs

Approach

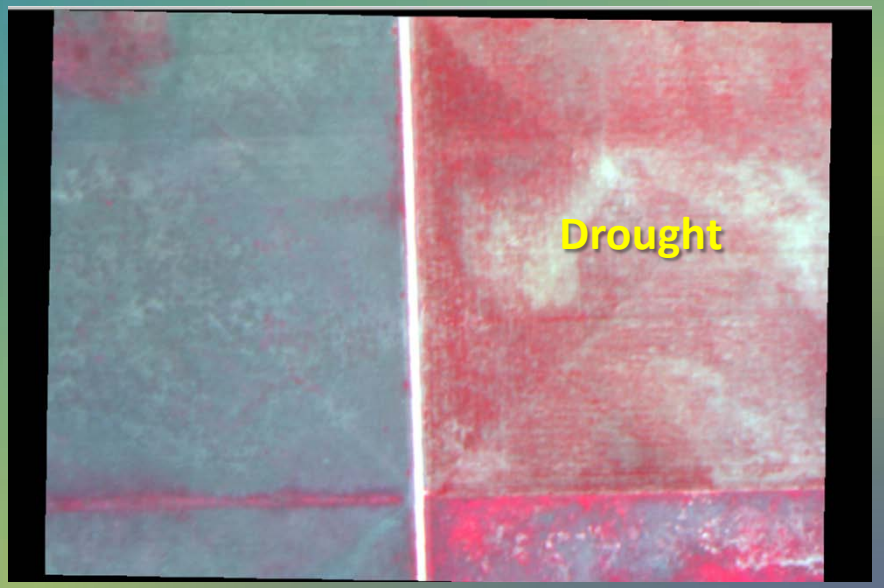
- Use multispectral remote sensing of wheat fields to create thematic maps of stressed fields using GIS
- Thematic maps were analyzed by spatial pattern metrics to differentiate stress caused by *D. noxia* from other stress factors

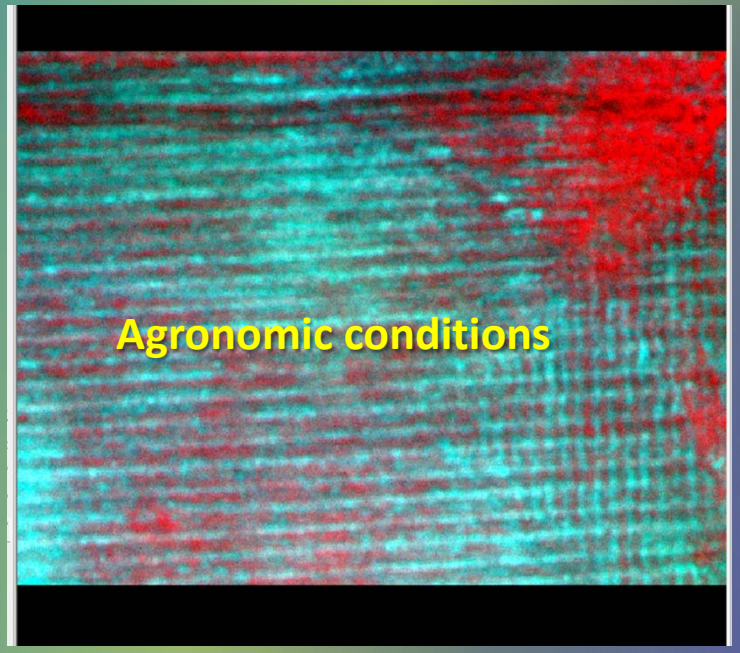
Methodology



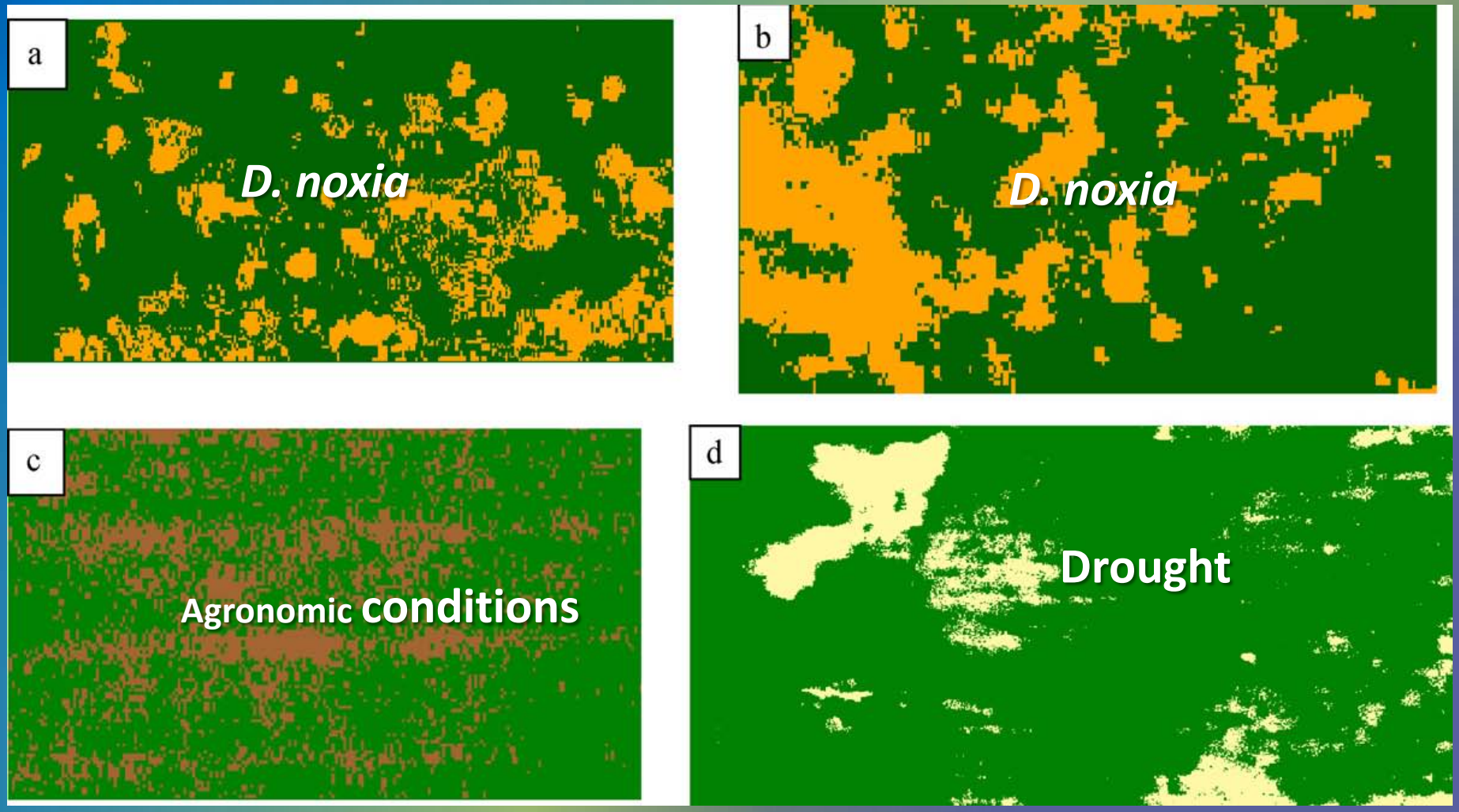
- ✓ Data acquisition
  - multispectral images using Duncan Tech MS 3100 camera

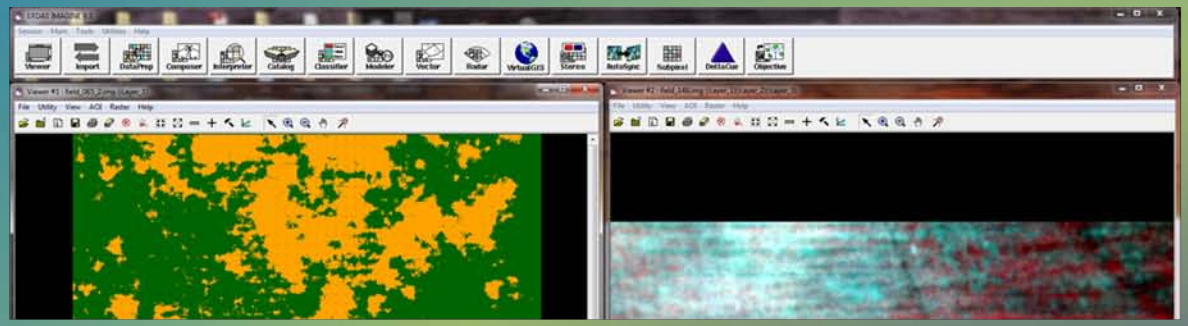

D. noxia


Drought

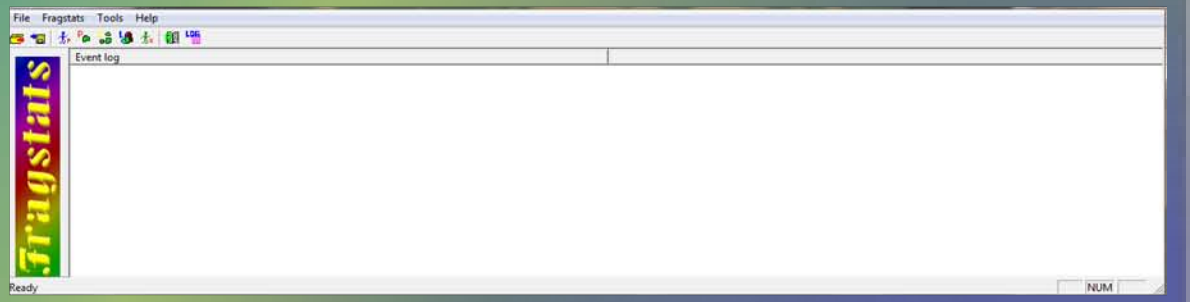

Agronomic conditions

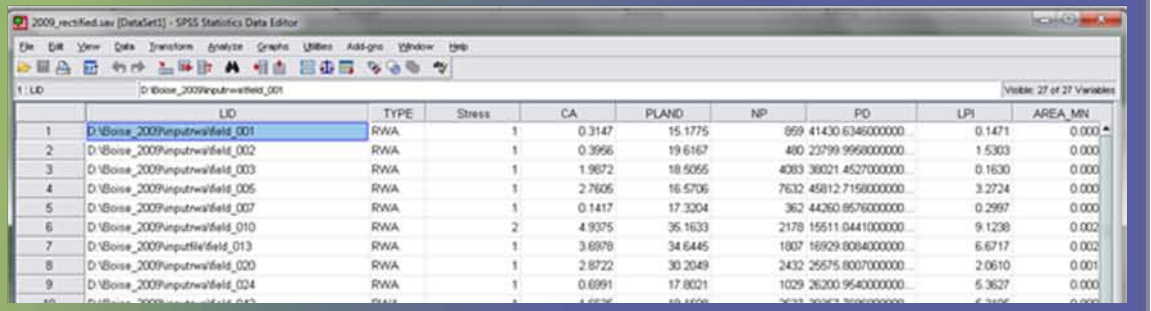
Classified images of wheat fields showing the predominant types of stress: (a) and (b) D. noxia, (c) agronomic conditions, and (d) drought. Color green represents areas of healthy wheat plants.





- Erdas Imagine version 9.3
- Fragstats version 3.3
- SPSS version 17





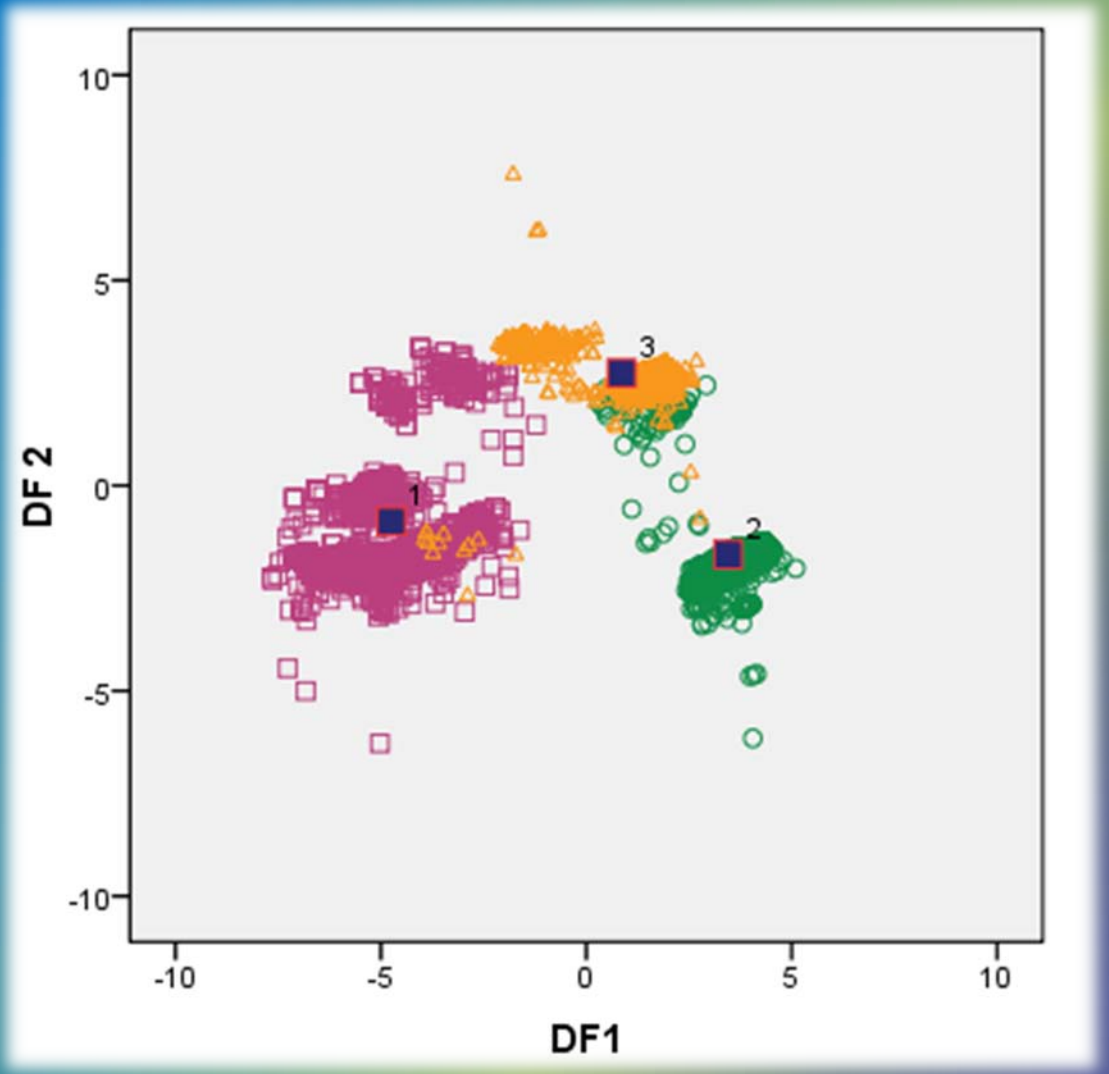
Brief description of each spatial metrics

Field configuration	Spatial metrics	Abbreviations	Description
Size	Patch area	AREA	The measure of the size (m2) of each patch within a wheat field
	Patch perimeter	PERIM	Total distance around each patch (m)
Shape	Shape Shape index	SHAPE	The ratio of patch perimeter to the minimum perimeter for the maximally compact patch of the same patch area across the class
	Fractal dimension index	FRAC	The ratio of 2 times logarithm of patch perimeter to logarithm of patch area
Distribution	Proximity index	PROX	The ratio of the sum of patch areas to the nearest edge-to-edge distance squared between patches in a specific radius
	Euclidean Nearest Neighbor Distance	ENN	The measure of the shortest straight-line distance between the focal patch and its nearest neighbor of the same class

Results

Field Configuration	Spatial metrics	*D. noxia*	Drought	Agronomic conditions	*P*-value
		Mean (SE)	Mean (SE)	Mean (SE)	
Size	PATCH AREA (m^2)	7.30 (1.11)	17:00(1.95)	3.14(0.81)	<0.0001
	PERIM (m)	16.30 (1.96)	26.57 (2.41)	7.43 (0.95)	<0.0001
Shape	SHAPE (unitless)	1.40 (0.02)	1.45 (0,03)	1.20 (0.02)	<0.0001
	FRAC (unitless)	1.12 (0.04)	1.60 (0.06)	0.87 (0.05)	<0.0001
Distribution	PROX (unitless)	78.96 (5.06)	38.90 (2.40)	27.64 (2.60)	<0.0001
	ENN (m)	1.80 (0.03)	1.20 (0.01)	1.40 (0.03)	<0.0001

Graph showing the spatial representation of each stress boundary



1. *D noxia*
2. Drought
3. Agronomic conditions
Group centroids

N=4943 Patches

Validation data

	Stress Types	Predicted Group Membership			Total Patches
		D. noxia	Drought	Agr. Conditions	
Count	*D. noxia*	454	0.0	9.0	463
	Drought	0.0	464	28	492
	Agr. Conditions	3.0	1.0	479	483
%	*D. noxia*	98.1	0.0	1.9	100.0
	Drought	0.0	94.3	5.7	100.0
	Agr. Conditions	0.6	0.2	99.2	100.0

Conclusion

- Potential exists to differentiate stress induces infested by *D. noxia* from other stress factors.
- Patch size, shape, and isolation\proximity metrics help in the stress differentiation
- Process required spatial pattern metrics from multispectral imagery
- Ultimate goal is to provide a non destructive, fast method for detecting infestation induced by the pest and ability to apply site specific pest control practices
- Does the potential exist to apply this approach to identify the factors from image products that describe the risk of infestation by Lygus bugs?

Acknowledgements

- Mr. Tim Johnson USDA-ARS Stillwater, OK
- Oklahoma Agricultural Experiment Station

End

- Thank you for listening