RECLAMATION

Managing Water in the West

Salt Cedar Beetle Monitoring on the Virgin River

U.S. Department of the Interior
Bureau of Reclamation

Background

- Tamarisk beetles introduced to the Virgin River in 2006 at St. George, Utah.
- Defoliation first noted late 2008, has since moved steadily downriver.
- Cooperative effort to understand impacts and potential implications:
  - Bureau of Reclamation MSCP and TSC
  - Utah Division of Wildlife Resources
  - SWCA Environmental Consultants

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Study Design

- Monitoring sites on the Virgin River:
  - St. George (defoliated)
  - Mormon Mesa (non-defoliated*)
- 25 monitoring locations at each site.
  - Observations recorded in 4 cardinal directions.
- Data collected approximately every 2 weeks
  - April through September, 2010 and 2011.

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Data Collection

- **Vegetation Characteristics:**
  - Foliar color
  - Canopy cover
  - Hemispherical photos (LAI, visible sky, ground covered)
- **Beetle Populations:**
  - Categorical counts by life stage
- **Microclimate**
  - Temperature and relative humidity

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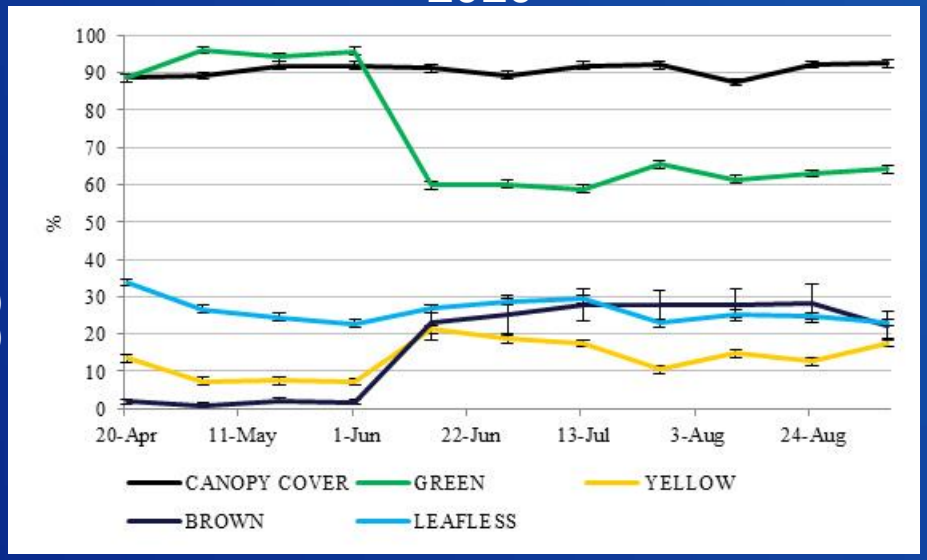
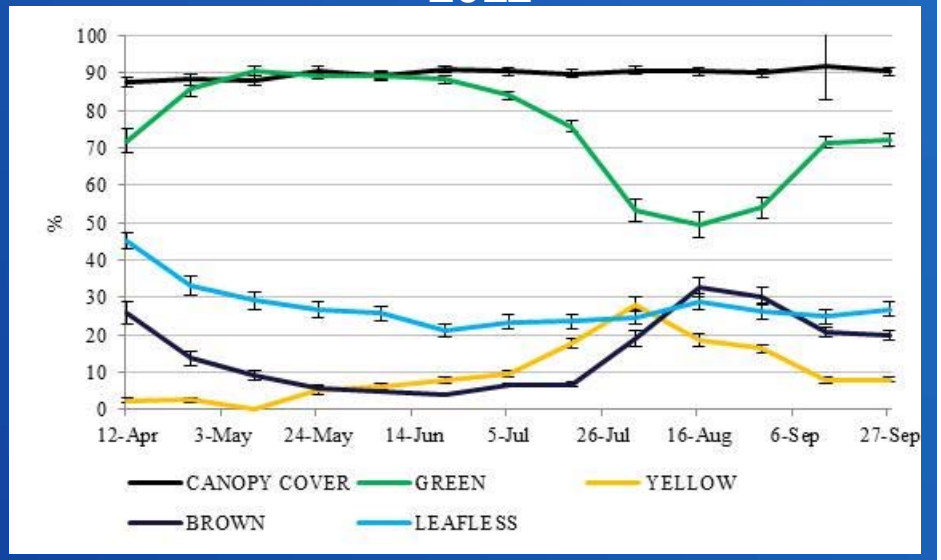
Results: Vegetation

2010 2011

SG





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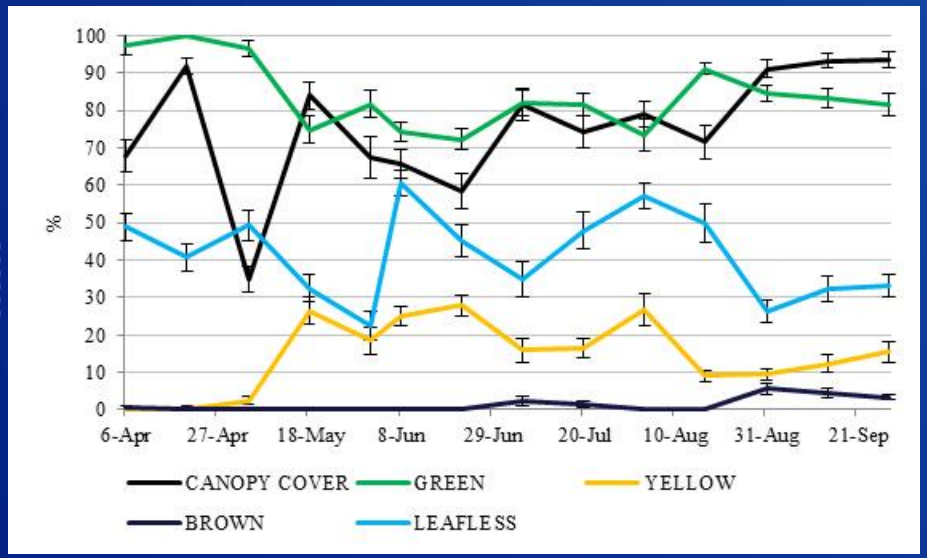
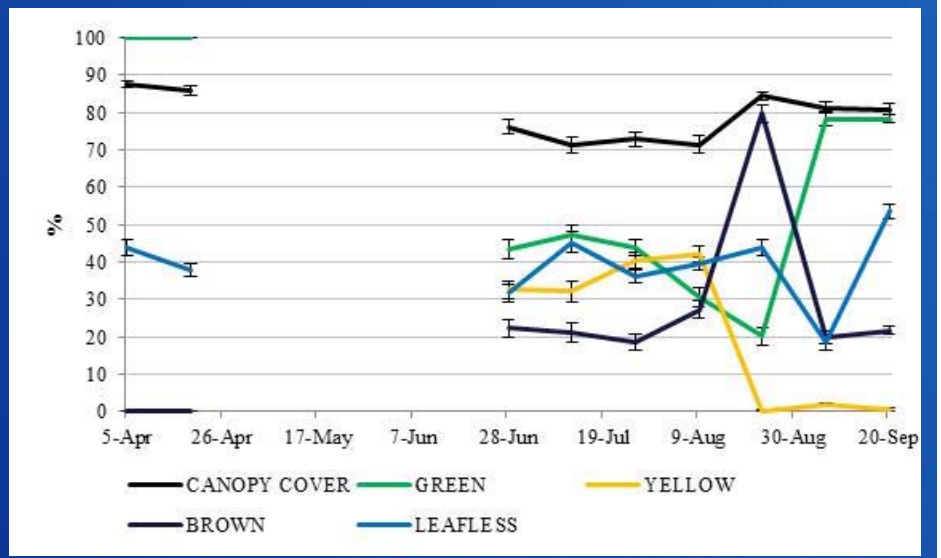
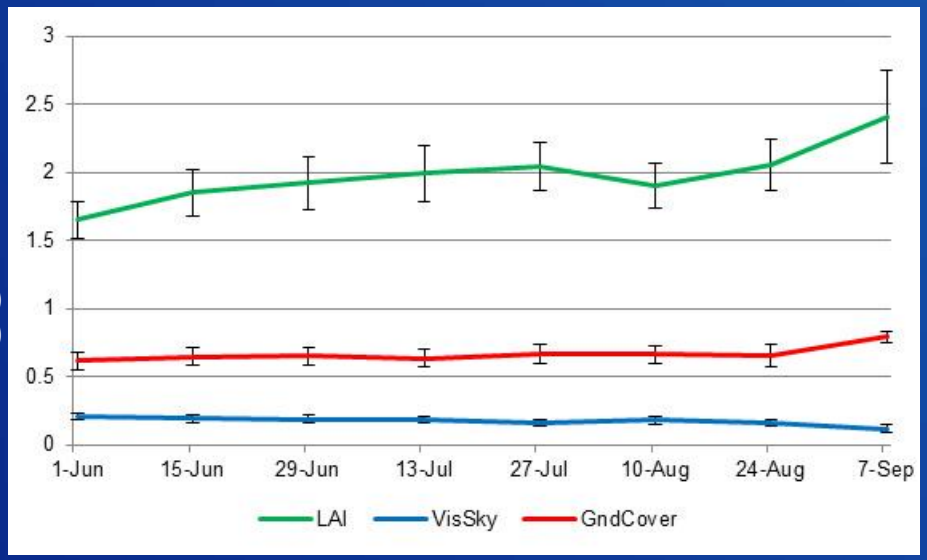


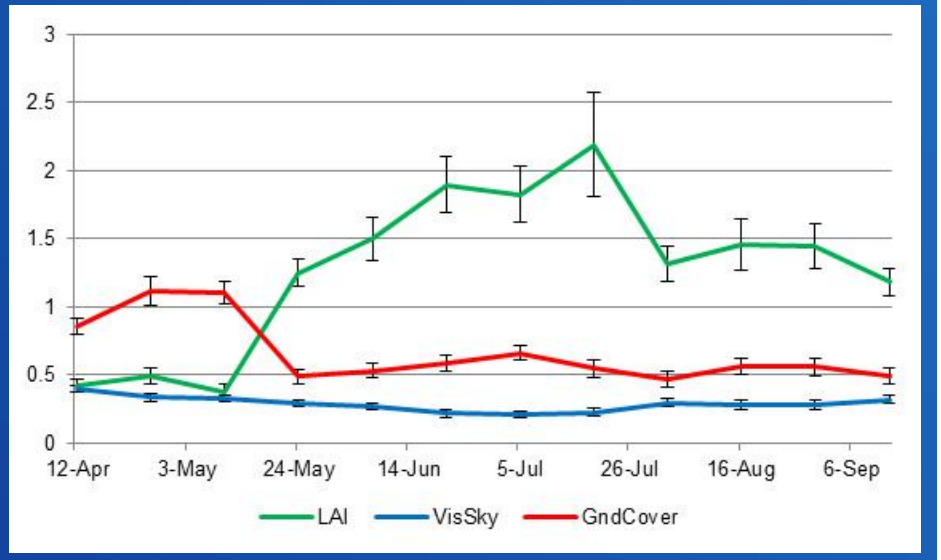


Hemispherical Photos

2010 2011

SG





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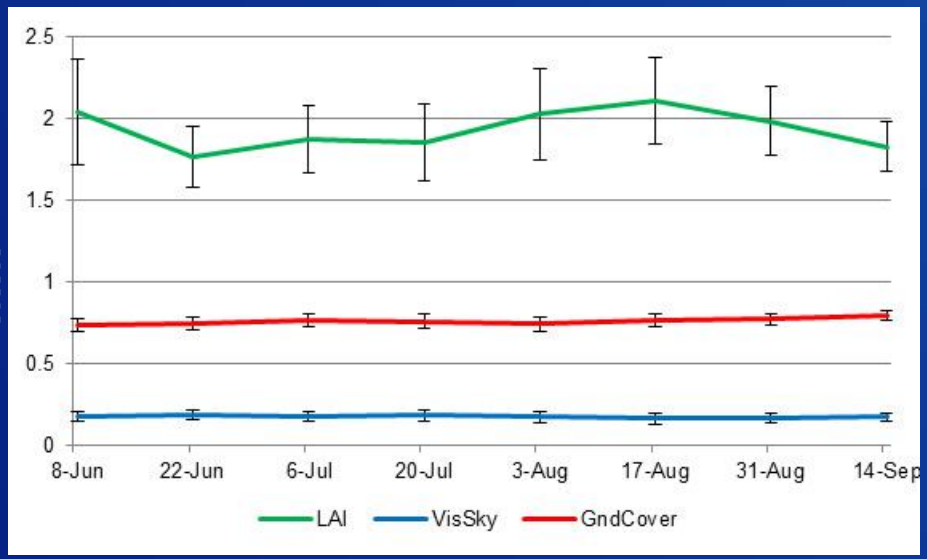
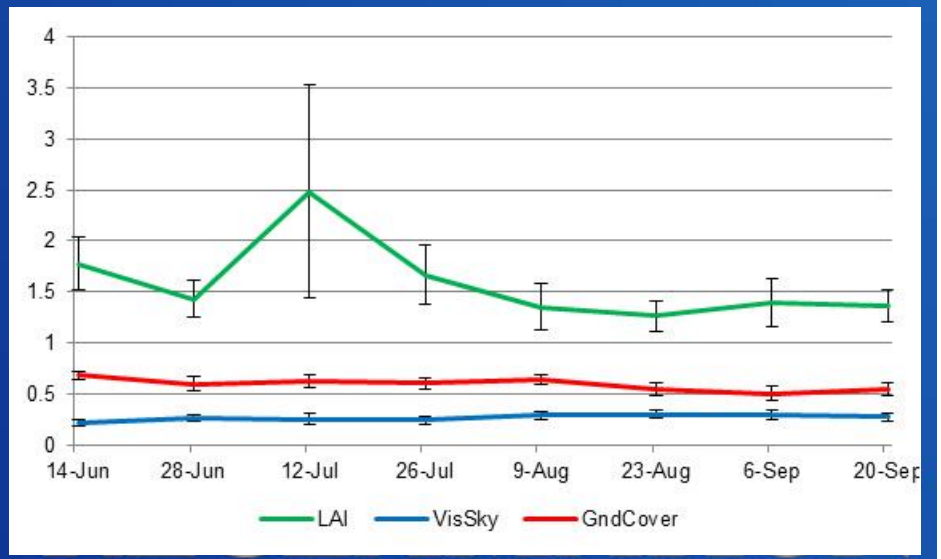


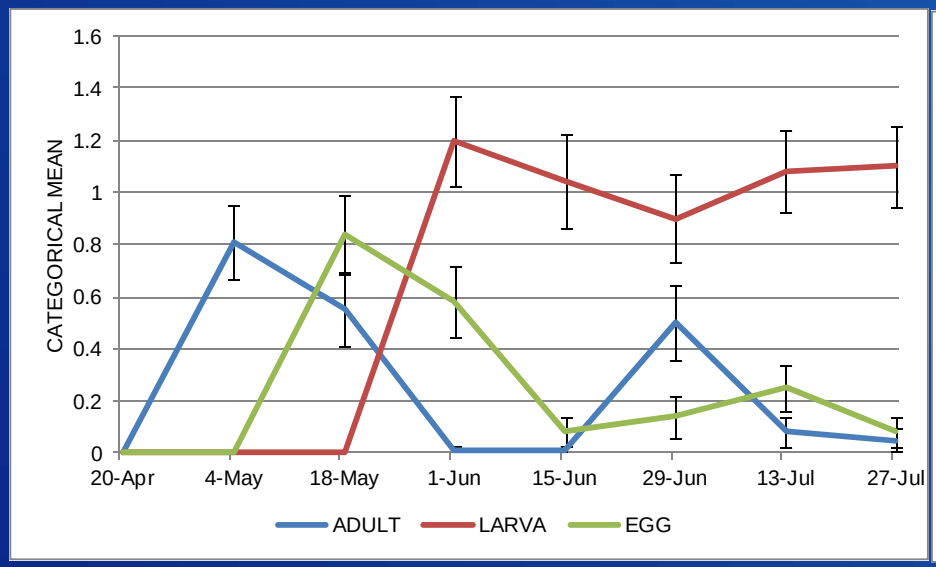


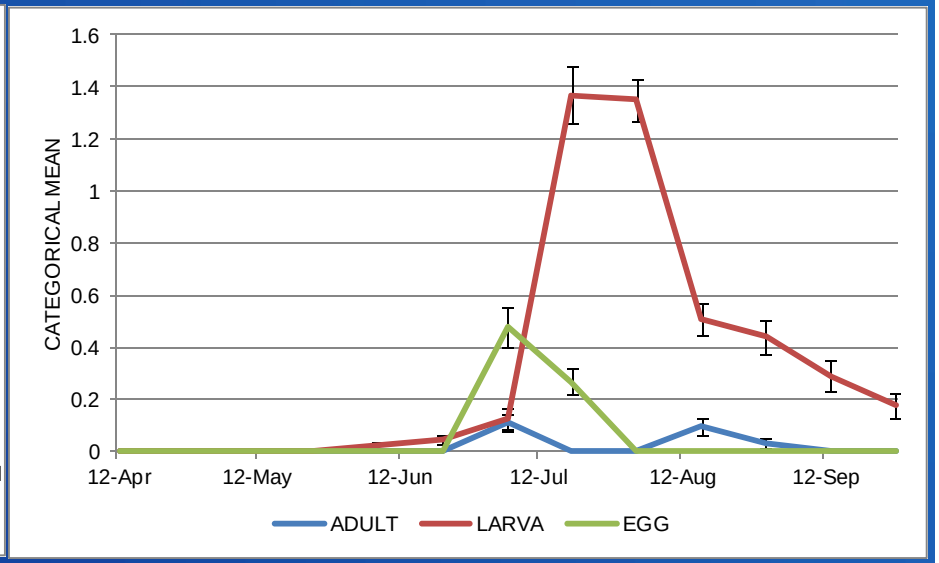
Beetle Populations

2010

2011

SG





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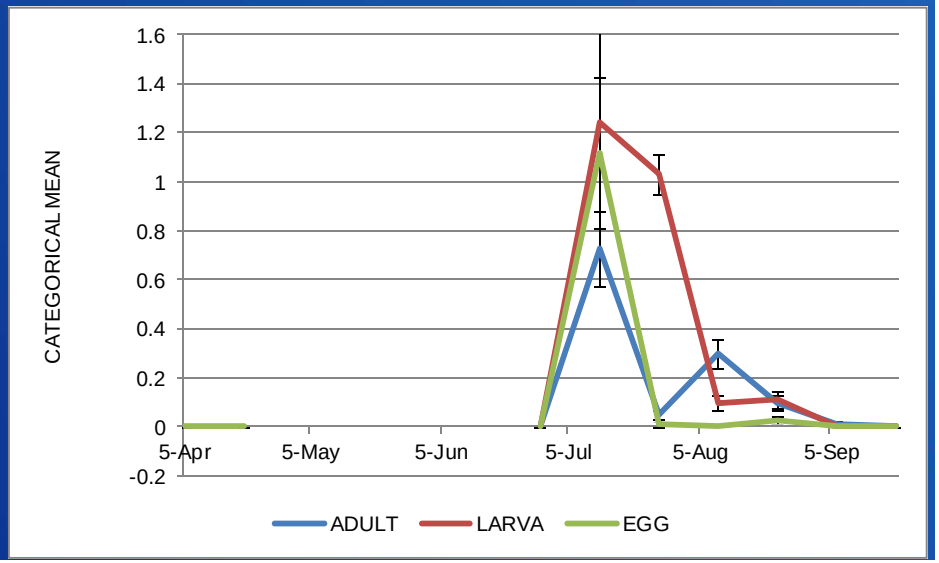
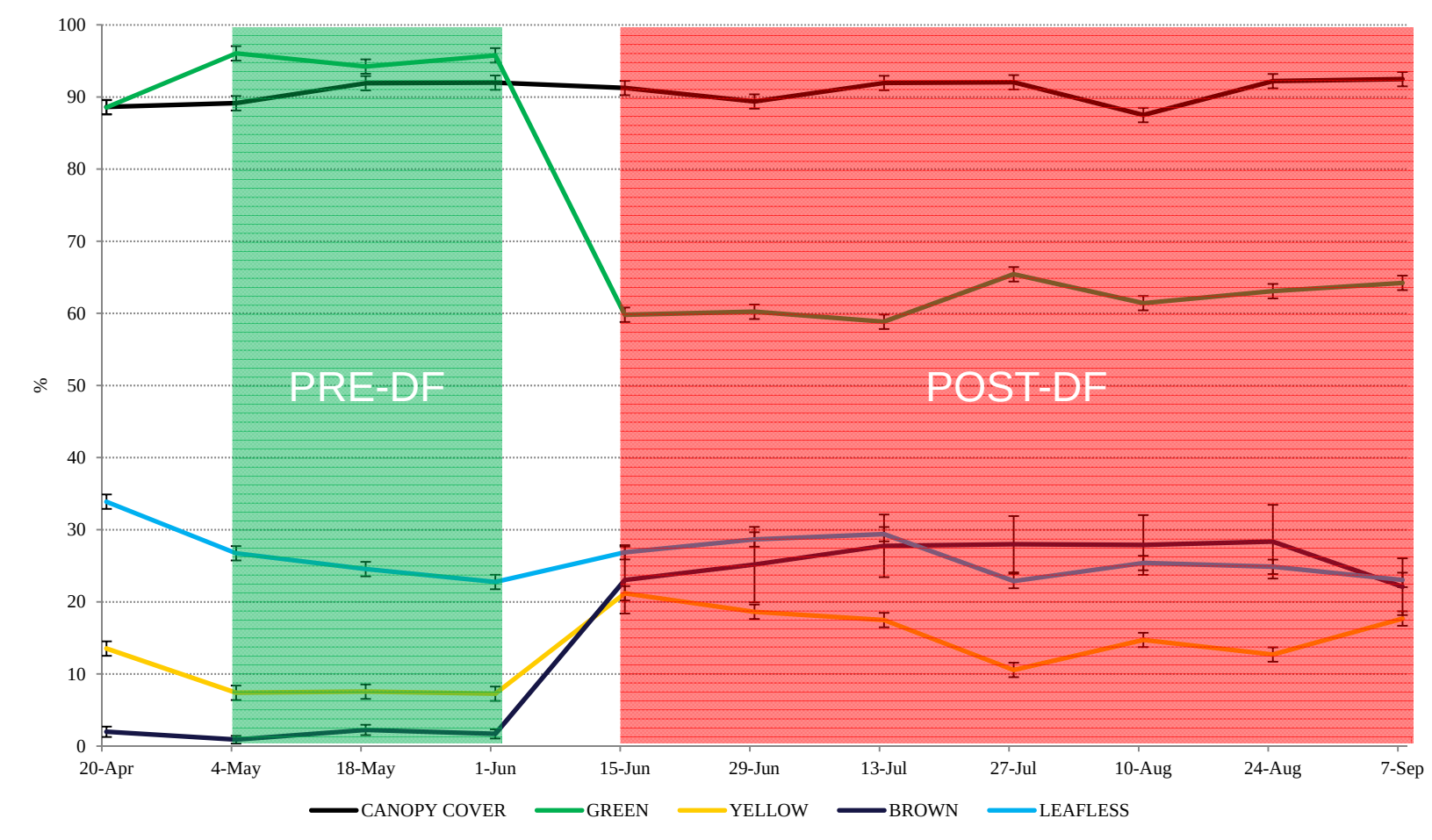


Vegetation Statistical Comparisons



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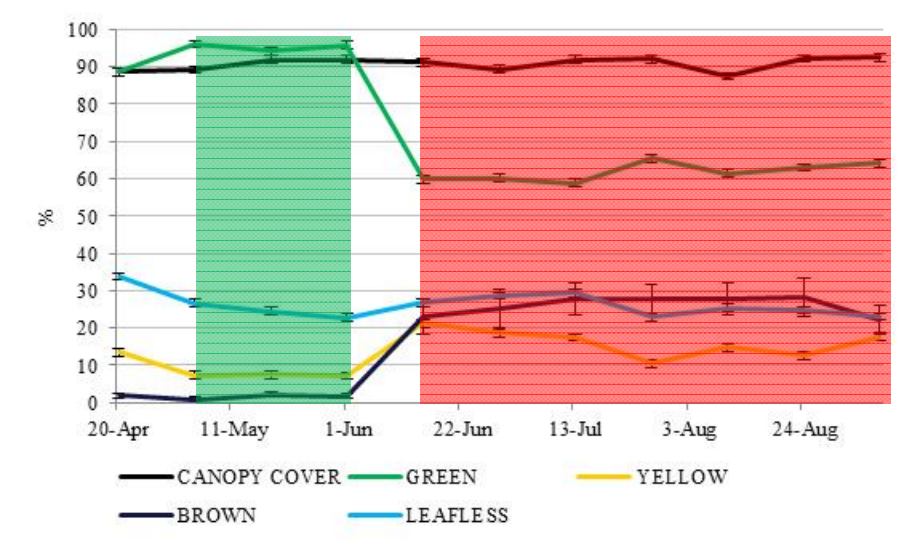
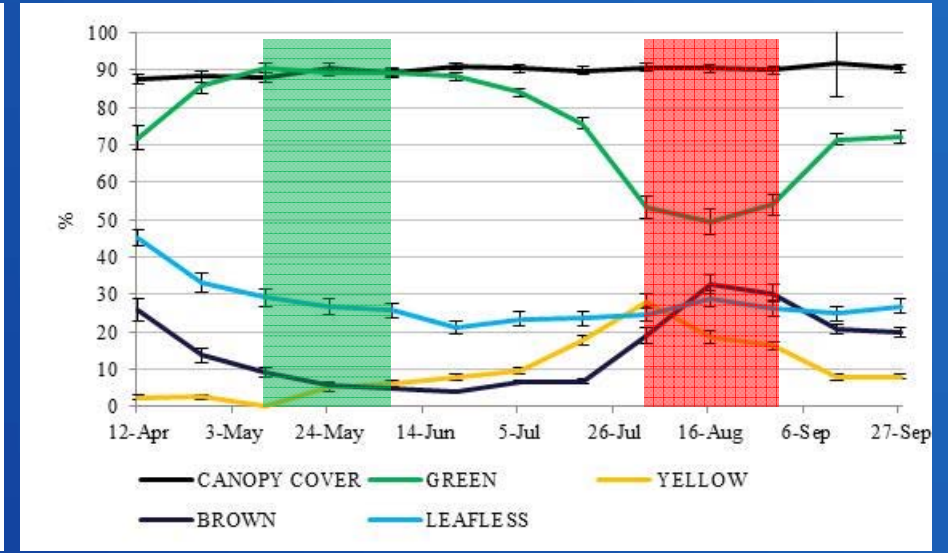
PRE and POST Defoliation Periods

2010 2011

SG





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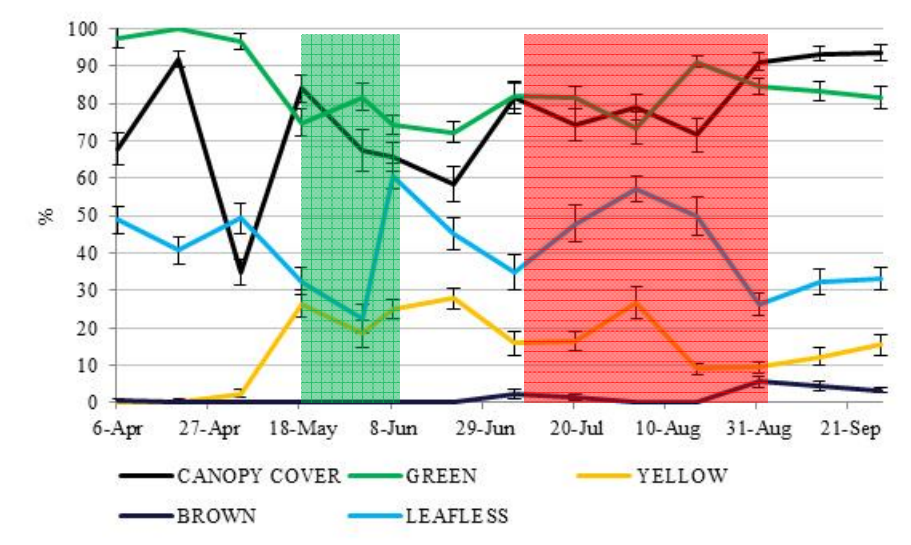
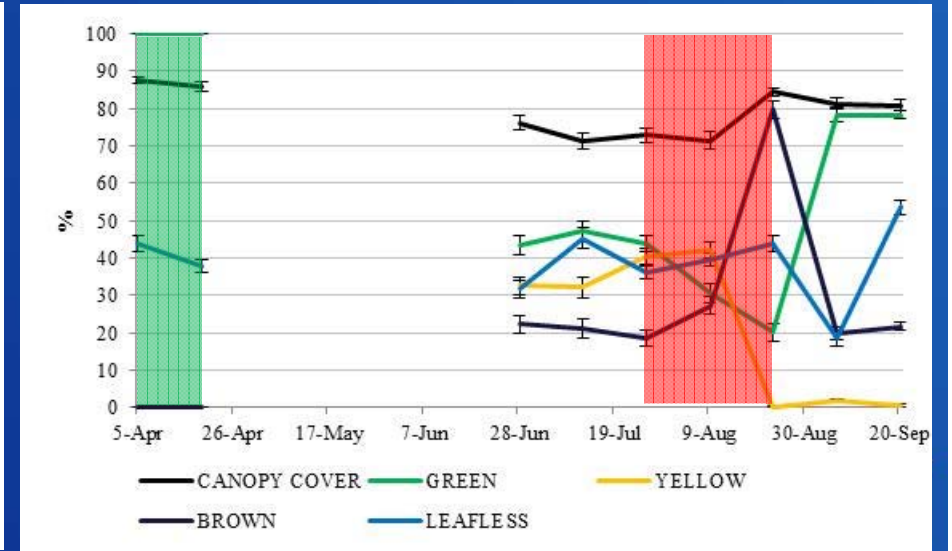
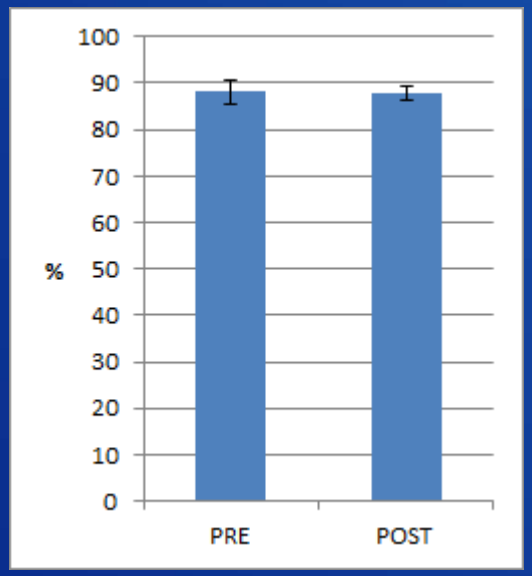
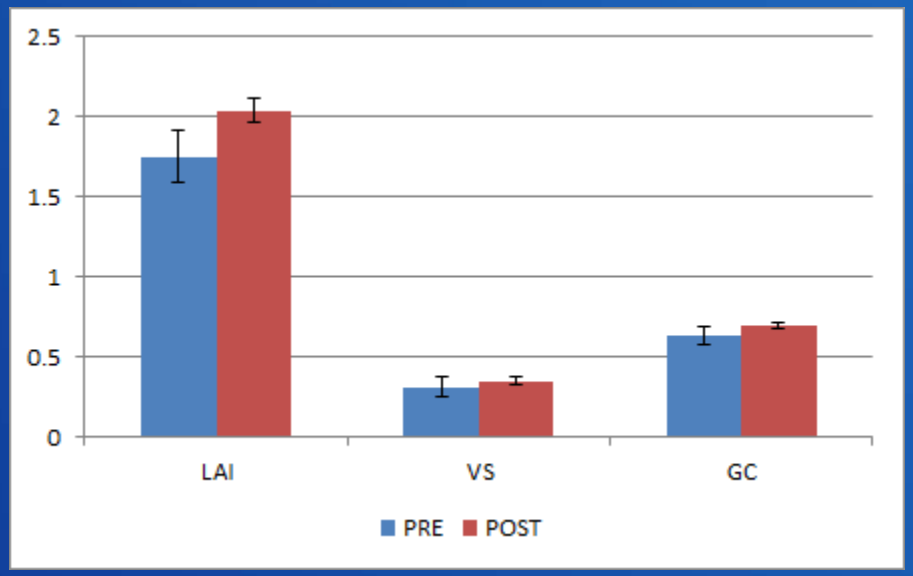




PRE vs POST Canopy Characteristics

SG





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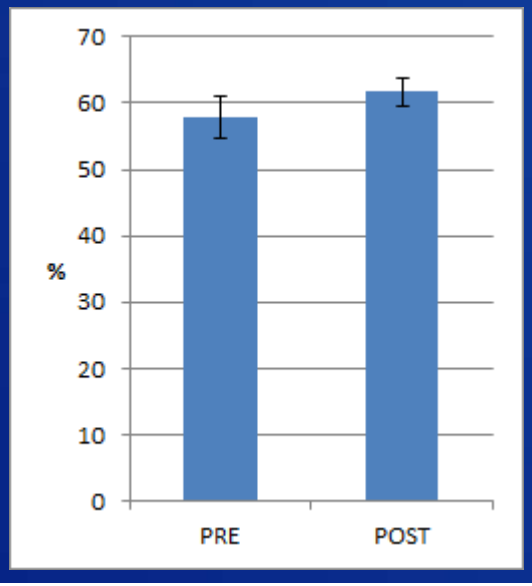

2010

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Vegetation Statistical Comparisons

- **St. George 2010: Pre vs. Post-Defoliation**

	PRE-DF MEAN (SE)	POST-DF MEAN (SE)	p-value
COVER	88.14 (2.48)	87.79 (1.61)	0.469
LAI	1.75 (0.16)	2.04 (0.07)	0.132
VIS SKY	0.31 (0.06)	0.35 (0.02)	0.626
GND COVER	0.63 (0.06)	0.69 (0.02)	0.272

- **Mormon Mesa 2010: Pre vs. Post-Defoliation**

	PRE-DF MEAN (SE)	POST-DF MEAN (SE)	p-value
COVER	57.73 (3.19)	61.73 (2.09)	0.240
LAI	-	-	-
VIS SKY	-	-	-
GND COVER	-	-	-

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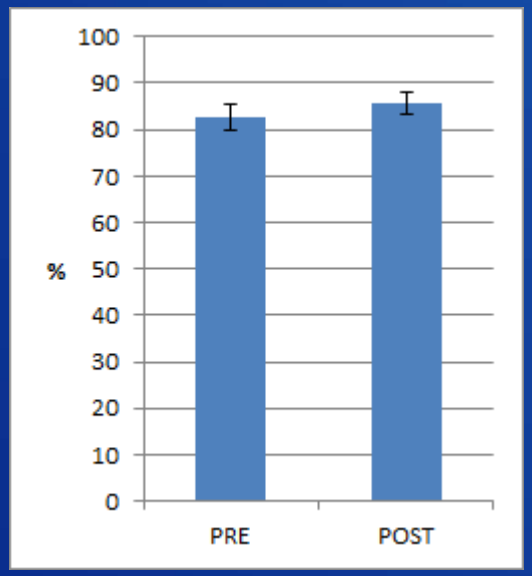
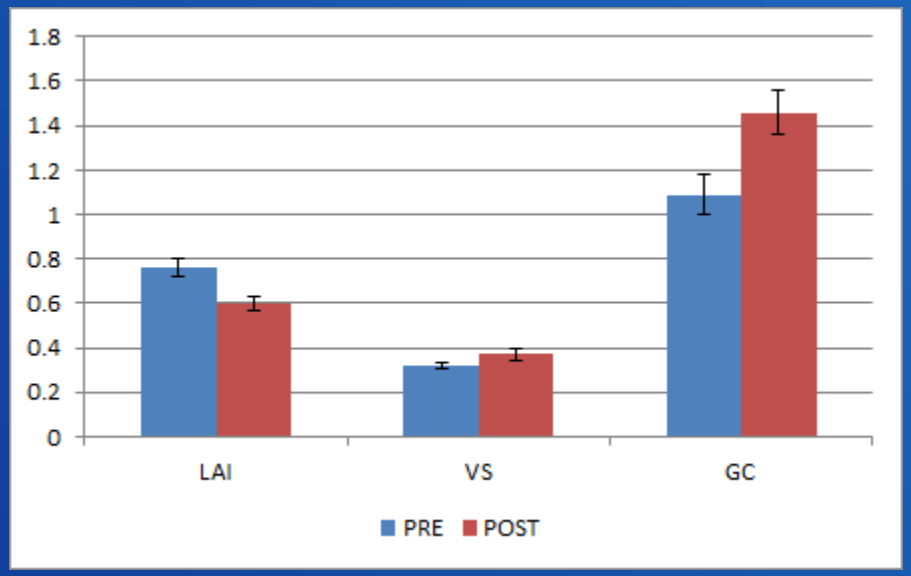
PRE vs POST Canopy Characteristics

SG





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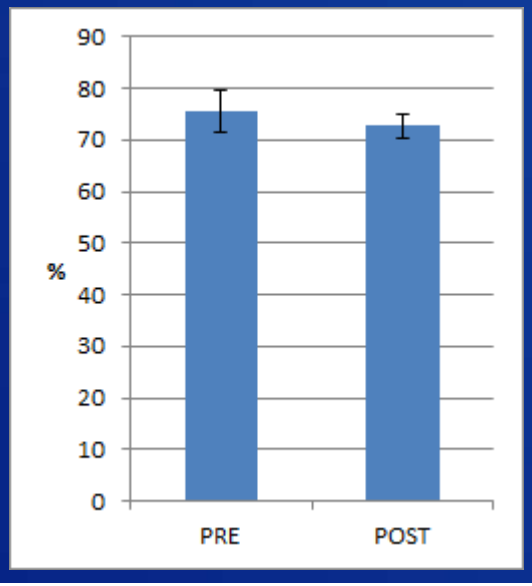

2011

RECLAMATION

Vegetation Statistical Comparisons

- **St. George 2011: Pre vs. Post-Defoliation**

	PRE-DF MEAN (SE)	POST-DF MEAN (SE)	p-value
COVER	82.51 (2.87)	85.87 (2.35)	0.362
LAI	0.76 (0.04)	0.60 (0.03)	0.062
VIS SKY	0.32 (0.01)	0.37 (0.03)	0.389
GND COVER	1.09 (0.09)	1.46 (0.10)	**0.005**

- **Mormon Mesa 2011: Pre vs. Post-Defoliation**

	PRE-DF MEAN (SE)	POST-DF MEAN (SE)	p-value
COVER	75.44 (4.05)	72.72 (2.37)	**0.002**
LAI	-	-	-
VIS SKY	-	-	-
GND COVER	-	-	-

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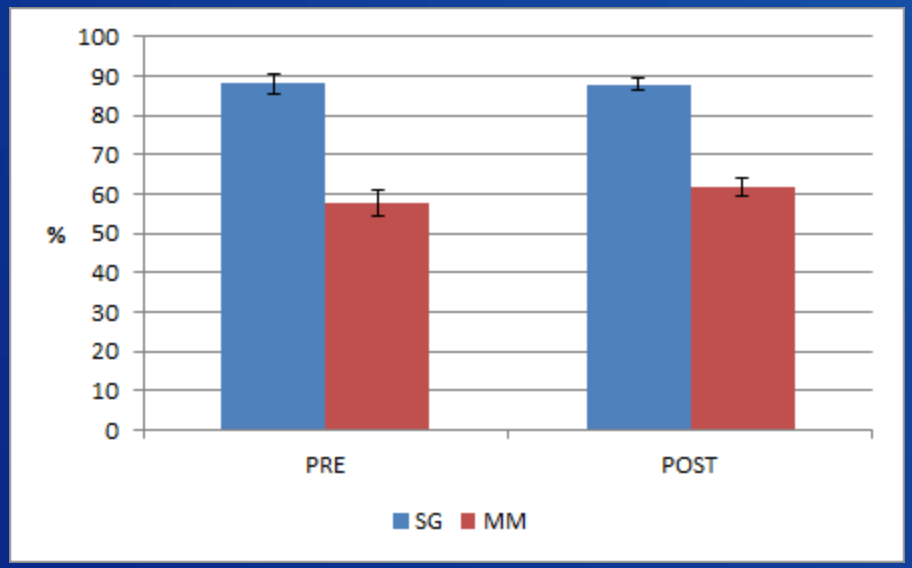
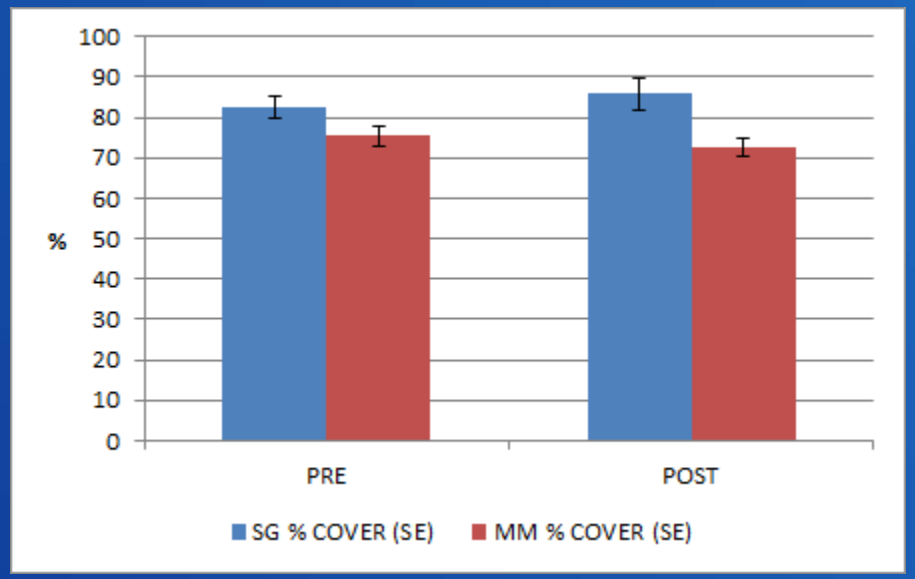
Between Site Canopy Cover Comparison

2010



	SG % COVER (SE)	MM % COVER (SE)	Δ	p-value
PRE	88.14 (2.48)	57.73 (3.19)	30.4	**<0.001**
POST	87.79 (1.61)	61.73 (2.09)	26.1	**<0.001**

2011



	SG % COVER (SE)	MM % COVER (SE)	Δ	p-value
PRE	82.51 (2.9)	75.44 (2.35)	7.1	**0.003**
POST	85.87 (4.1)	72.72 (2.37)	13.2	**<0.001**

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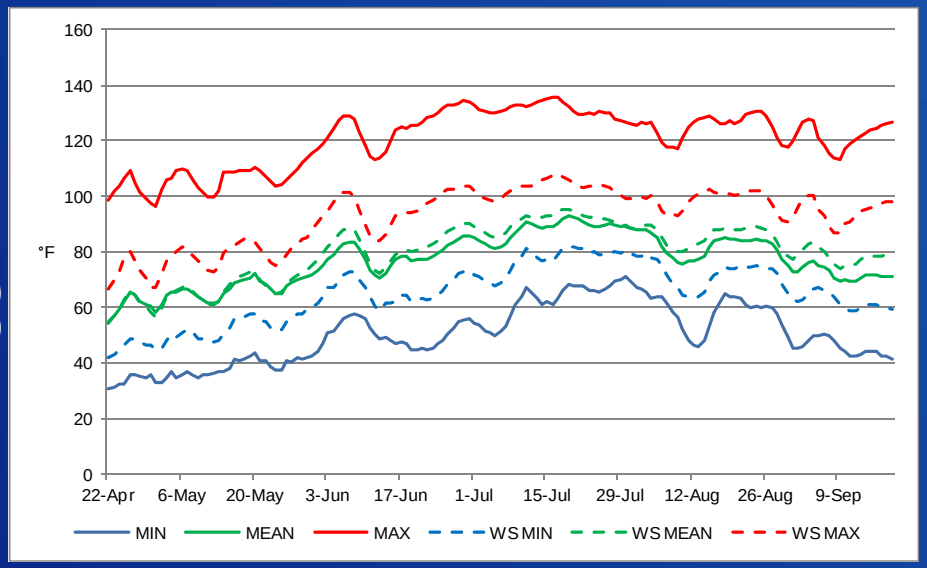
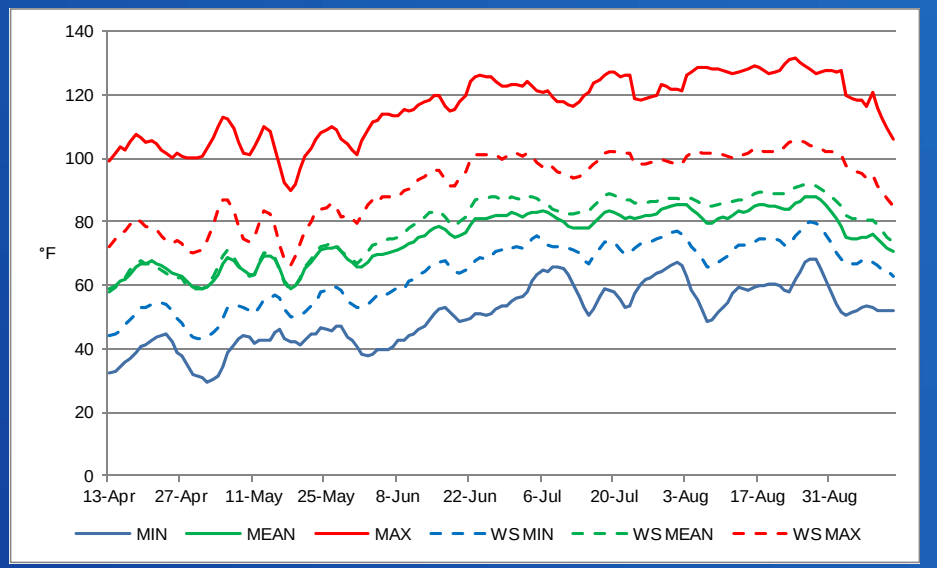
Microclimate: Temperature

2010

2011

SG





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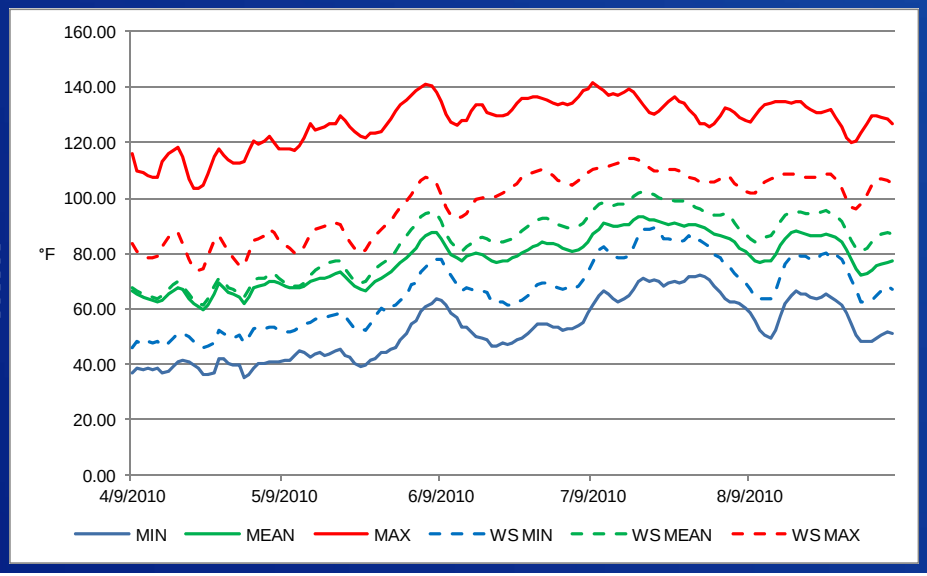
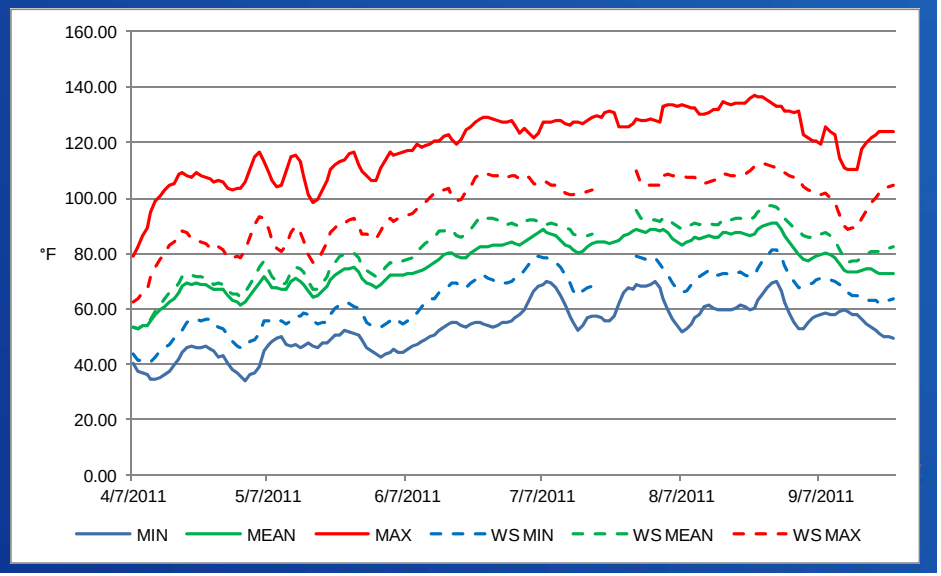
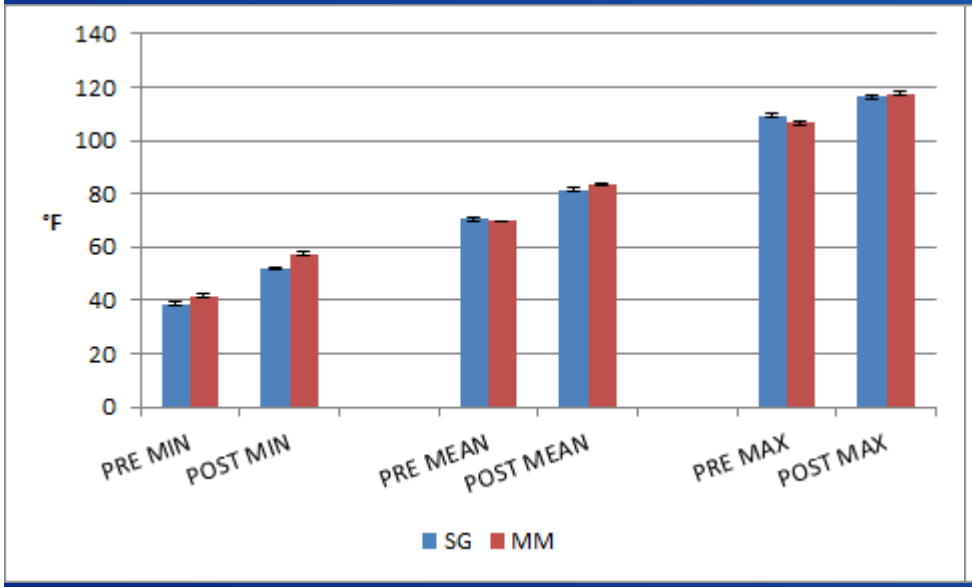
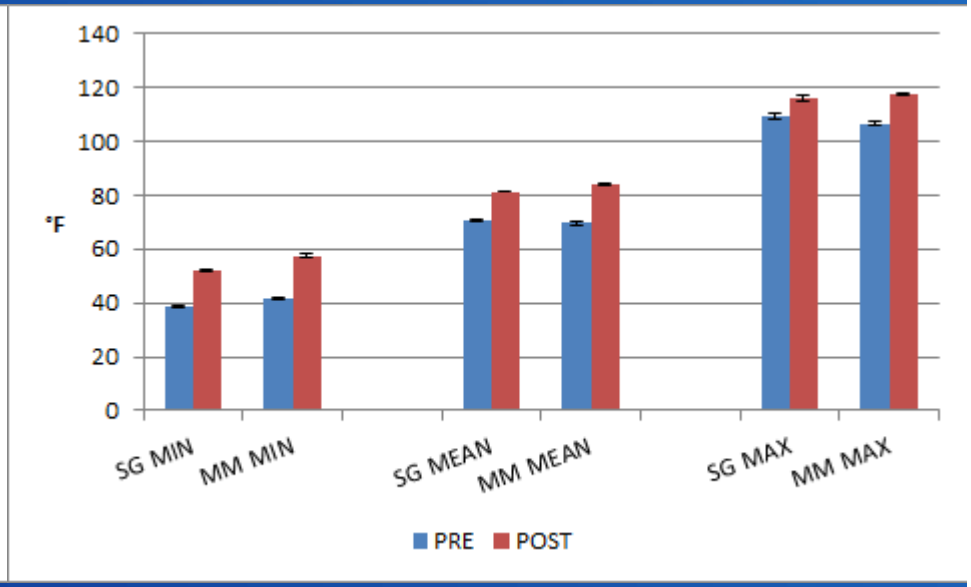




Temperature and Defoliation: 2010





PRE

	SG MEAN (SE)	MM MEAN (SE)	p-value
MIN	-12.6 (0.65)	-9.5 (0.42)	**<0.001**
MEAN	-3.4 (1.07)	-4.3 (0.28)	**<0.001**
MAX	15.99 (1.75)	13.8 (1.03)	**0.001**

SG

	PRE-DF MEAN (SE)	POST-DF MEAN (SE)	p-value
MIN	-12.6 (0.65)	-13.62 (0.30)	**0.002**
MEAN	-3.4 (1.07)	-4.0 (0.47)	**0.006**
MAX	15.99 (1.75)	12.72 (0.90)	**0.003**

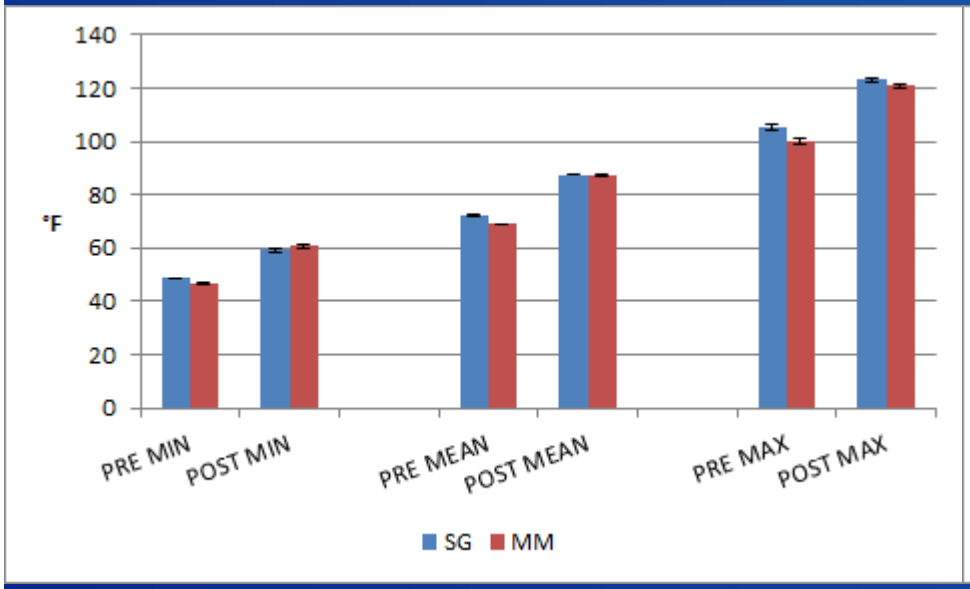
POST

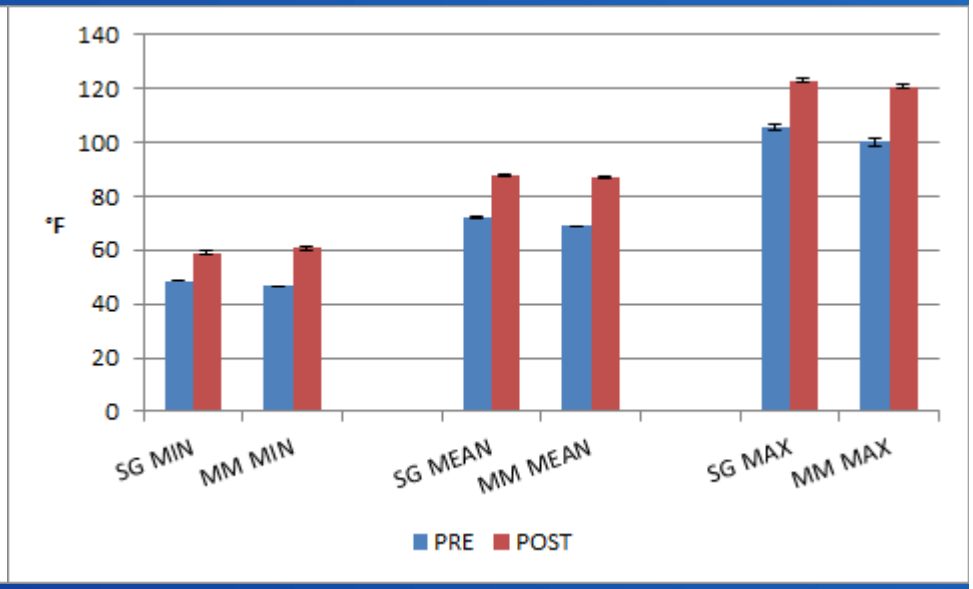
	SG MEAN (SE)	MM MEAN (SE)	p-value
MIN	-13.62 (0.30)	-13.93 (0.77)	**<0.001**
MEAN	-4.0 (0.47)	-10.5 (1.10)	**<0.001**
MAX	12.72 (0.90)	6.0 (1.62)	**<0.001**

MM

	PRE-DF MEAN (SE)	POST-DF MEAN (SE)	p-value
MIN	-9.5 (0.42)	-13.93 (0.77)	**0.007**
MEAN	-4.3 (0.28)	-10.5 (1.10)	**<0.001**
MAX	13.8 (1.03)	6.0 (1.62)	**0.002**

Temperature and Defoliation: 2011





PRE

	SG MEAN (SE)	MM MEAN (SE)	p-value
MIN	-12.6 (0.65)	-9.5 (0.42)	**<0.001**
MEAN	-3.4 (1.07)	-4.3 (0.28)	**<0.001**
MAX	15.99 (1.75)	13.8 (1.03)	**0.001**

SG

	PRE-DF MEAN (SE)	POST-DF MEAN (SE)	p-value
MIN	-3.3 (0.44)	-14.7 (0.86)	**<0.001**
MEAN	7.7 (0.67)	-1.0 (0.42)	**<0.001**
MAX	28.9 (1.66)	21.0 (0.78)	**0.003**

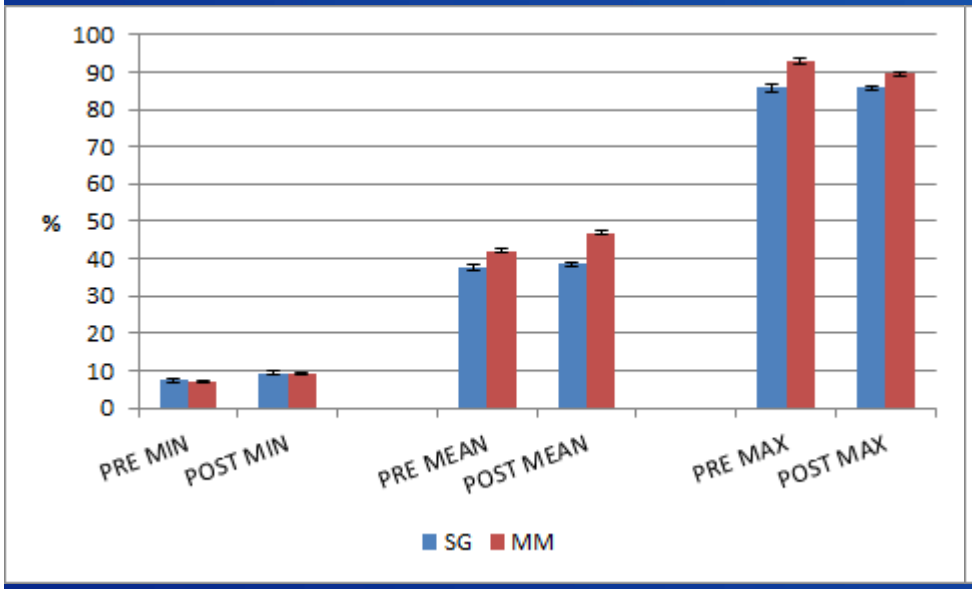
POST

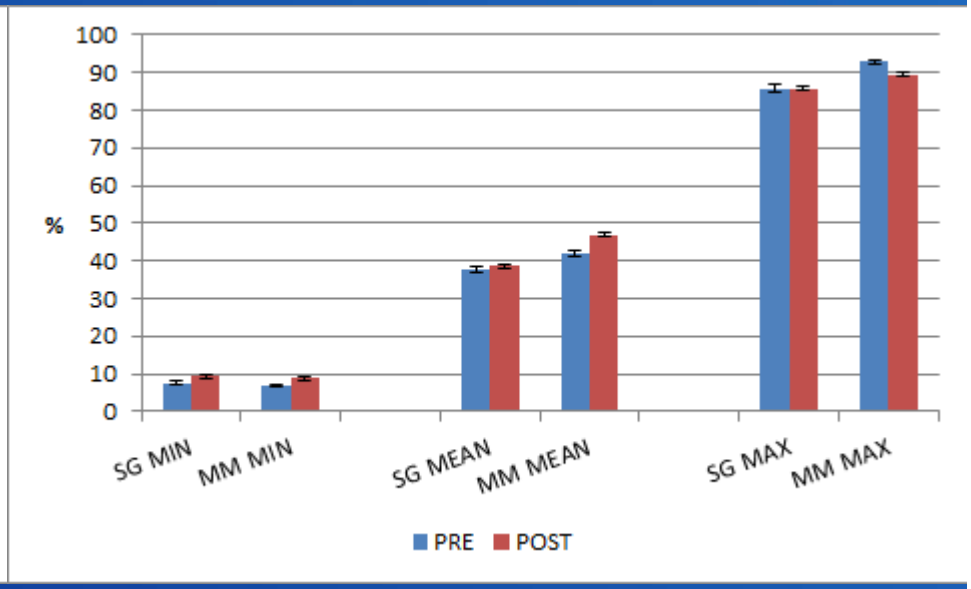
	SG MEAN (SE)	MM MEAN (SE)	p-value
MIN	-13.62 (0.30)	-13.93 (0.77)	**<0.001**
MEAN	-4.0 (0.47)	-10.5 (1.10)	**<0.001**
MAX	12.72 (0.90)	6.0 (1.62)	**<0.001**

MM

	PRE-DF MEAN (SE)	POST-DF MEAN (SE)	p-value
MIN	-5.7 (0.24)	-9.5 (0.23)	**<0.001**
MEAN	-3.3 (0.20)	-6.7 (0.28)	**<0.001**
MAX	10.7 (1.30)	9.9 (0.76)	**<0.001**

Relative Humidity: 2010





PRE

	SG MEAN (SE)	MM MEAN (SE)	p-value
MIN	-1.0 (0.51)	-2.1 (0.29)	**0.289**
MEAN	13.1 (1.04)	19.3 (0.58)	**<0.001**
MAX	21.54 (1.74)	45.9 (0.56)	**<0.001**

SG

	PRE-DF MEAN (SE)	POST-DF MEAN (SE)	p-value
MIN	-1.0 (0.51)	1.1 (0.45)	**0.002**
MEAN	13.1 (1.04)	13.9 (0.80)	**0.518**
MAX	21.54 (1.74)	18.28 (1.72)	**0.435**

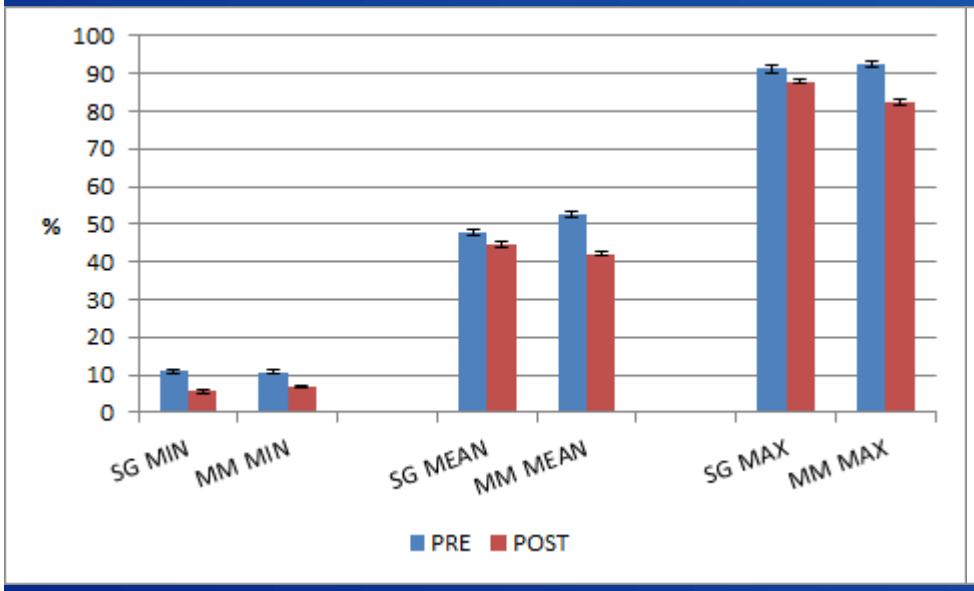
POST

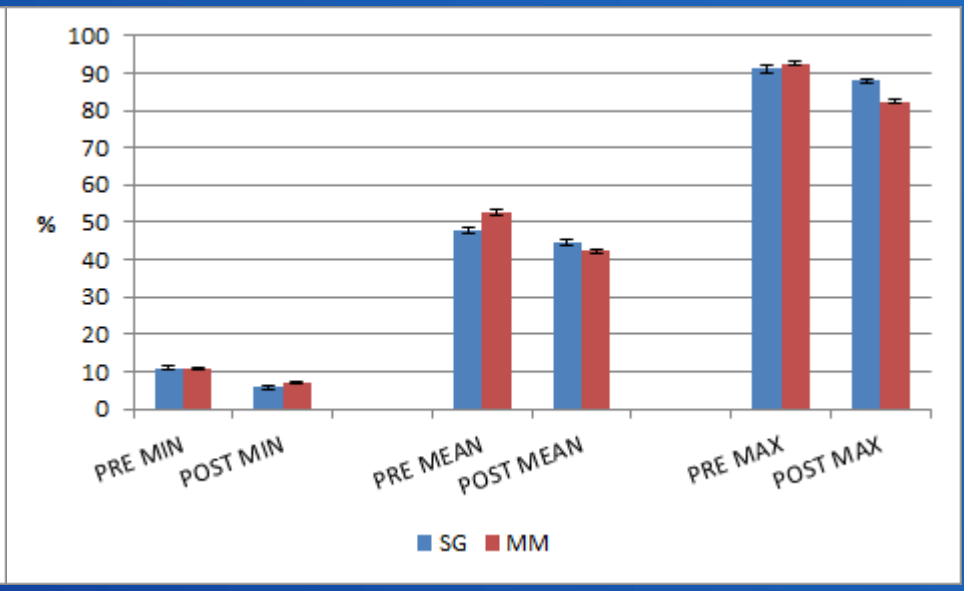
	SG MEAN (SE)	MM MEAN (SE)	p-value
MIN	1.1 (0.45)	0.2 (0.25)	**0.690**
MEAN	13.9 (0.80)	25.64 (0.77)	**<0.001**
MAX	18.28 (1.72)	43.5 (1.32)	**<0.001**

MM

	PRE-DF MEAN (SE)	POST-DF MEAN (SE)	p-value
MIN	-2.1 (0.29)	0.2 (0.25)	**<0.001**
MEAN	19.3 (0.58)	25.64 (0.77)	**<0.001**
MAX	45.9 (0.56)	43.5 (1.32)	**0.005**

Relative Humidity: 2011





PRE

	SG MEAN (SE)	MM MEAN (SE)	p-value
MIN	1.2 (0.58)	-2.2 (0.50)	**<0.001**
MEAN	18.9 (0.92)	20.3 (1.00)	**0.206**
MAX	11.94 (1.47)	30.48 (1.29)	**<0.001**

SG

	PRE-DF MEAN (SE)	POST-DF MEAN (SE)	p-value
MIN	1.2 (0.58)	-2.68 (0.21)	**<0.001**
MEAN	18.9 (0.92)	18.0 (0.64)	**0.662**
MAX	11.94 (1.47)	26.6 (0.95)	**<0.001**

POST

	SG MEAN (SE)	MM MEAN (SE)	p-value
MIN	-2.68 (0.21)	-0.3 (0.28)	**<0.001**
MEAN	18.0 (0.64)	23.15 (0.71)	**<0.001**
MAX	26.6 (0.95)	37.1 (1.05)	**<0.001**

MM

	PRE-DF MEAN (SE)	POST-DF MEAN (SE)	p-value
MIN	-2.2 (0.50)	-0.3 (0.28)	**0.002**
MEAN	20.3 (1.00)	23.15 (0.71)	**0.002**
MAX	30.48 (1.29)	37.1 (1.05)	0.021

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